



CN-140, 9N
BIB. 74-91 C.1

ENERGY:

AN ANNOTATED BIBLIOGRAPHY

COMPILED BY SANDRA J. BLOW

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HAMPTON, VIRGINIA

INTRODUCTION

This bibliography is a compilation of approximately 4,300 selected references on energy and energy related topics.

The references are arranged by date, with the latest works first, in the following subject categories: (1) Energy and power - general; resources, supply/demand, and forecasting; policy, legislation, and regulation; research and development; environment; consumption and economics; and conservation. (2) Energy and power sources - general, fossil fuels, hydrogen and methanol, organic wastes and waste heat, nuclear, geothermal, solar, wind, ocean/water, magnetohydrodynamics and electrohydrodynamics, and gas and steam turbines. (3) Energy and power storage and transmission.

Literature from bibliographic sources dated January 1972 through July 1974 is covered, with some pertinent literature prior to 1972 included.

The following bibliographic sources were used:

Langley Research Center book and document card files
NASA RECON
NSF-RANN Energy Abstracts
Nuclear Science Abstracts
NTIS Weekly Government Abstracts - Energy
Science Abstracts, Section B - Electrical and Electronics Abstracts
Engineering Index
Fuel Abstracts

2 13/20/79

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I. ENERGY AND POWER

NASA SP-7042 Energy: A Special Bibliography with Indexes

A literature survey of 1708 selected, annotated documents on research and development in energy and energy-related subjects produced or received by NASA from 1968 through 1973. The referents are grouped in the following subject categories: Energy systems; solar energy; primary energy sources; secondary energy sources derived from the primary sources; energy conversion, including magnetohydrodynamics and fuel cells; energy transport, transmission, and distribution; and energy storage.

National Aeronautics and Space Adm., Wash., D.C.
Scientific & Technical Information Office Apr. 1974.

(ORNL-EIS-74-52 (Vol. 2) (No. 1)) NSF-RANN ENERGY ABSTRACTS. A Monthly Abstract Journal of Energy Research. Guthrie, M. P. (Ed.). (Oak Ridge National Lab., Tenn. (USA)). Jan 1974. Contract W-7405-eng-26. 45p. Dep. NTIS \$4.00.

The bibliography contains ninety-three research citations from technical journal articles, popular or semi-technical magazine articles, topical reports, symposium papers and proceedings, monographs, and books published within the past two years. Citations are grouped by subject category headings of energy, energy sources, unconventional energy sources and power generation, electric power, electric power generation, electric power transmission and distribution, energy storage, and energy demand and consumption. (MCW)

Engineer-Index's *Energy Abstracts*. Publications are divided into five categories, each of which will be available in individual subsets. These are: Energy Sources (\$18.50 for 9 months); Energy Production, Transmission, and Distribution (\$93.50); Energy Utilization (\$37.50); Energy Conservation (\$14.50); and Energy Conversion (\$37.50). The monthly *Energy Abstracts* will be available either as a complete set or in any of the above subsets. The complete set—beginning with the first issue, published in March, 1974—costs \$187.00 for 9 issues. They can be ordered from Engineering Index, Inc., 345 E. 47th St., N. Y., N. Y. 10017.

N74-19638# Defense Documentation Center, Alexandria, Va.
ENERGY CONVERSION Report Bibliography. Jan. 1974 - Aug. 1973

Jan. 1974 409 p refs

(AD-771750; DDC-TAS-74-2) Avail: NTIS CSCL 10/2
The bibliography is a compilation of 287 references on Energy Conversion. Citations are sequenced numerically within each of the following categories: (1) Fuel Cells; (2) Mineral Fuels; (3) Nuclear Energy; (4) Solar Energy; (5) Steam Power; (6) Thermionic Generators; (7) Thermoelectric Generators; (8) Geopolitical Energy Studies; and (9) Miscellaneous Studies. Corporate Author-Monitoring Agency, Subject, Title, Personal Author, Contract Number, and Report Number Indexes are included. Author (GRA)

Thermal Pollution. A Bibliography with Abstracts.

Edward J. Lehmann.

National Technical Information Service, Springfield, Va. Jul 74. 316p NTIS-WIN-74-052

COM-74-11139/4WE PC\$20.00/MF\$20.00

This bibliography contains 307 selected abstracts of research reports retrieved using the NTIS on-line search system - NTISearch. The cited reports have been divided into three topics: Control techniques, biological effects, and hydrology. The first section covers all phases of thermal pollution control including costs, techniques, and feasibility. The biological studies include all aspects of the effects of heated effluents on fish, microorganisms, and plants. This involves the effects on such things as growth, the ecology, metabolism, and heat tolerance. The third section concerns the hydrology and hydrodynamics of heated effluents, primarily their modeling. Such studies cover mixing, diffusion, heat transfer, and flow.

A. GENERAL

1974

Automobile Air Pollution. A Bibliography with Abstracts.

Edward J. Lehmann.

National Technical Information Service, Springfield, Va.

May 74, 277p NTIS-WIN-74-039

COM-74-10968/7WP PCS20.00/MFS20.00

This bibliography contains 271 selected abstracts of research reports covering the period 1970 to April 1974 retrieved using the NTIS on-line search system--NTISearch. The abstracts are broken down into five sections covering the abatement and control of automobile air pollution. These sections are: General studies (37 abstracts); Urban transportation planning and management (45 abstracts); Control methods and equipment (79 abstracts); Automotive fuel effects, additive effects, and new fuel types (35 abstracts); New engines (46 abstracts); and Exhaust analysis (25 abstracts). Smog and diesel engine research is excluded. (Author)

BIBLIOGRAPHY OF ENERGY

Science, v.184, no.4134, Apr.19,1974.

A list of articles on energy published in recent issues of Science.

Energy Supply and Demand and the Availability of Energy Sources. A Bibliography with Abstracts.

Edward J. Lehmann.

National Technical Information Service, Springfield, Va. Jul

74, 167p NTIS-WIN-74-048

COM-74-11102/2WE PCS20.00/MFS20.00

The bibliography contains 159 selected abstracts of research reports retrieved using the NTIS on-line search system--NTISearch. The report is divided into two sections. In the first, references are cited which estimate future energy supply and demand and present government energy policies. The second section covers the current and future availability of new and old sources of energy such as petroleum, coal, natural gas, solar, hydrogen, and others.

N74-20705# Defense Documentation Center, Alexandria, Va.
ENERGY SOURCES - CITATIONS FROM THE EARLY DDC
COLLECTIONS Report Bibliography, Mar. 1933 - Jun. 1962
Jan. 1974 25 p refs

(AD-773325; DDC-TAS-74-10) Avail: NTIS CSCL 21/4

This bibliography consists of 121 citations on Energy Sources dated March 1933 to June 1962. These are not in the collection of the DDC Automated Data Banks. They are arranged by ATI (Air Technical Index) numbers, and are available via regular DDC document request procedures. GRA

Fuel, Energy and the Steel Industry. A Bibliography.

D. G. Brinn.

British Steel Corp., Sheffield (England). Information

Services. Apr 74, 20p SM/TN/1/35

PB-232 236/0WE PCS4.00/MFS1.45

The bibliography, which consists of seventy four annotated references, has been organized under the following headings:-
(i)The overall energy situation; (ii)The energy situation and the steel industry; (iii)Fuel and energy management in the steel industry; (iv)Reports of fuel and energy savings in steel industry; (v)The coal situation; (vi)Electricity supplies; (vii)Oil and gas; (viii)Steelmaking and nuclear energy.

CENTER FOR ENERGY STUDIES. This report covers the past accomplishments and present capabilities of the Kansas State University College of Engineering in the power and energy related research. This report contains abstracts of technical articles, reports, theses and dissertations written by the faculty, staff, and students. The abstracts are classified into five sections: general and systems analysis, solar and wind energies, magnetohydrodynamics, nuclear energy, environmental effects and energy resources from wastes and fuel production. Each section is subdivided into four sub-sections: Journal Articles, Presented Papers, Reports, and Theses and Dissertations. The order within each subsection is arranged chronologically.

For. L.T. Kan State Univ, Inst Syst Des Optimization. Rep n 50 Jul 1973, 24 p.

1973

N74-18623# Decision Sciences Corp., Jenkintown, Pa.
**QUANTITATIVE ENERGY STUDIES AND MODELS: A
 STATE OF THE ART REVIEW**

Philip R. Limaye, Robert Ciliano, and John R. Sharkey [1973]
 50 p refs Sponsored by Council on Environmental Quality,
 Executive Office of the President

Avail: NTIS HC \$5.50

A state of the art review of quantitative energy studies and
 models is summarized. The objective of this review was to evaluate
 analytical studies of energy relative to the development of a
 comprehensive model for analyzing the probable environmental
 consequences of energy policy options. The review includes an
 examination of the significant characteristics of each study and
 a comprehensive bibliography of the current research work
 involving analytical techniques for the evaluation of energy policy
 issues. Author

Quantitative Energy Studies and Models: A State of the Art Review: Appendix I

Decision Sciences Corp., Jenkintown, Pa.

Presents in two volumes a comprehensive review of quan-
 titative energy studies and models in order to evaluate
 energy policy options. Mar. 1973. 95 pp. PC \$4.85/MF
 \$1.45 order PB-220-131

Quantitative Energy Studies and Models: A State of the Art Review: Appendices II and III

Decision Sciences Corp., Jenkintown, Pa.

Lists all energy studies and models reviewed by DSC for
 the Council of Environmental Quality. Gives detailed in-
 formation relating to the formal project titles, documenta-
 tion, research, and sponsoring agencies, descriptive ab-
 stracts, and key personal contacts associated with the
 study. Mar. 1973. 113 pp. PC \$5.45/MF \$1.45 order PB-
 220-132

N74-18312# Defense Documentation Center, Alexandria, Va.
**ENVIRONMENTAL POLLUTION: AIR POLLUTION (EX-
 HAUST GASES)** Report Bibliography, Jan. 1971 - Jul.
 1973

Dec. 1973 94 p refs

(AD-771710: DDC-TAS-73-77) Avail: NTIS CSCL 13/3

The bibliography comprises citations of unclassified reports
 dealing with exhaust gases in a series of bibliographies on air
 pollution. Topics discussed include air pollution from exhaust
 gases emanating from ground and air transportation. There are
 also included some references to exhaust systems of jet engines,
 helicopters, turbojet engines, and rocket motors. Corporate
 Author-Monitoring Agency, Subject, Title, Personal Author,
 Contract, and Report Number indexes are included.

Author (GRA)

N74-11849# Atomic Energy Commission, Washington, D.C.
**ENERGY R AND D INVENTORY DATA BASE. BIBLIOGRA-
 PHY, 1973**

1973 439 p refs

Avail: NTIS HC \$24.00

The bibliography provides separate listings which include:
 (1) index on authors, (2) simple index on corporate authors, (3)
 permuted index on titles, (3) energy sources (arranged according
 to the various types), (4) electric power generation (subdivided
 by type), and (5) energy demand and uses. DLG.

**The Energy Index: A Select Guide to Energy In-
 formation Since 1970.** 1973. Environment Infor-
 mation Center, Energy Reference Dept., 124 E.
 39th St., New York, N. Y., 10016. 522 pp.,
 paper. \$50.00.

The guide contains more than 2000 ab-
 stracts of articles, government documents,
 congressional hearings, research reports,
 newspaper articles, and conference pro-
 ceedings. In addition to the abstracts sec-
 tion with a variety of indexes there is a ref-
 erence section containing statistical data, a
 lengthy list of books and films, abstracts of
 key energy laws and patents issued since
 1971.

1973

N74-12695# Oak Ridge National Lab., Tenn.
ENERGY RESEARCH AND DEVELOPMENT: A SELECTED READING LIST
 M. P. Guthrie, ed., E. E. Huber, ed., and G. A. Norwood, ed.
 (AEC, Washington, D. C.) Nov. 1973 107 p. Revised
 (Contract W-7405-eng-26; NSF-IA-AAA-R-479)
 (ORNL-EIS-73-65-Rev. 1) Avail: NTIS HC \$7.50

A selected list of readings designed to aid policymakers in the identification of promising areas for energy research and development is presented. The document is also designed to assist the informed layman who wishes to orient himself in this overall field. The genesis of the reading list was a need to gain a perspective on what has already been done in energy research and development. This perspective was required to support the development of a report to the President from the Chairman of the Atomic Energy Commission on long-range energy research and development needs and policy as requested in the President's June 29, 1973, statement on Energy and National Resources. A basic aim was to include monographs and reports on technology assessment for each of the many energy technologies. The bibliography emphasizes general publications on energy sources, electric power, generation, and energy uses. Detailed technical reports and scientific papers are included only to a limited extent. A special effort was made to include Congressional publications relating to energy.

N74-17660 Central Electricity Generating Board, London (England).
ECONOMETRIC MODELS: THEIR APPLICATION TO THE ECONOMIC AND ENERGY SECTORS
 G. G. Kinnane, comp. Dec. 1973 26 p. refs
 (CE-Bibi-220) Avail: Issuing Activity
 A bibliography of abstracts on econometric models and their application to the economy and energy sectors is presented. The bibliography has 101 references.

E.H.W.

N74-10391# Ecole Polytechnique Federale de Lausanne (Switzerland). Centre de Recherches en Physique des Plasmas.
ENERGY: COMPILED BIBLIOGRAPHY AND TABLES OF WORLD RESOURCES, CONSUMPTION, AND WASTES [ENERGIE: COMPILATION BIBLIOGRAPHIQUE ET TABULATION DES RESSOURCES, DE LA CONSOMMATION ET DES DECHETS DANS LE MONDE]
 M. Roux Jul. 1973 66 p. refs. in French; English summary
 Sponsored by Fonds Natl. Suisse de la Rech. Sci.
 (LRP-63/73) Avail: NTIS HC \$5.50 ~~440~~ N73-30975#

The available resources of fossil and nuclear fuels, as well as those of solar energy, hydroelectric power and others, are reviewed and compared to global consumption of energy. The per capita and global consumption, together with its growth rate, are presented with respect to primary energy sources and/or main sectors of use. Attention is focused on the energy required by electrical power generation, and estimates up to 2000 are given. Chemical and radioactive nuclear wastes resulting from either energy consumption or electrical power generation are tabulated and scaled to the energy consumption. Wastes from the nuclear economy are estimated up to 2000. The relative biological hazards pertaining to radioactive inventories and fission reactor wastes are compared to those of a reference reactor.

N74-20827# Oak Ridge National Lab., Tenn.
ENERGY RESEARCH AND DEVELOPMENT: A SELECTED READING LIST
 M. P. Guthrie, ed., E. E. Huber, ed., and G. A. Norwood, ed.
 Nov. 1973 237 p. Sponsored by NSF
 (Contract W-7405-eng-26)
 (ORNL-EIS-73-65) Avail: NTIS HC \$14.00

A selected listing of 1,219 publications is assembled for the identification of promising areas for energy research and development. The document is designed to assist the layman. The genesis of the reading list was a need to gain a perspective on what has already been done in energy research and development. The perspective was required to support the development of a report to the President from the Chairman of the AEC on long-range energy research and development needs and policy as requested in the President's June 29, 1973, statement on Energy and National Resources. The bibliography emphasizes general publications on energy sources, electric power, generation, energy uses, and references on energy supply and demand studies. An appendix includes an author index, a simple title index, and a permuted index on titles.

NSA

(COM-73-11490-2-GA) AUTOMOBILE AIR POLLUTION: A BIBLIOGRAPHY WITH ABSTRACTS. Report for 1970-May 1973. Lehmann, E. J. (National Technical Information Service, Springfield, Va. (USA)). Jul 1973. 146p. (NTIS-WIN-73-34). NTIS \$20.00.

The NTIS bibliography contains 134 selected abstracts of research reports covering the period 1970 to May 1973 retrieved using the NTIS on-line search system - NTISearch. The abstracts are broken down into five sections covering the abatement and control of automobile exhaust: General studies (27 abstracts); Urban transportation planning and management (30 abstracts); Control methods (19 abstracts); Automotive fuel effects, additive effects, and new fuel types (23 abstracts); New engines (18 abstracts); and Exhaust analysis (17 abstracts). Smog and diesel engine research is excluded. (GRA)

(COM-73-11582-6-GA) DISPOSAL AND UTILIZATION OF WASTES FROM ENERGY PRODUCTION: A BIBLIOGRAPHY WITH ABSTRACTS. Report for 1970-May 1973. Lehmann, E. J. (National Technical Information Service, Springfield, Va. (USA)). Aug 1973. 84p. (NTIS-WIN-73-39). NTIS \$20.00.

The NTISearch bibliography contains 78 selected abstracts of research reports retrieved using the NTIS on-line search system - NTISearch. The bibliography presents generalized studies concerning environmental factors of both thermal and nuclear power plants. These studies cover the abatement and control techniques for water pollution, air pollution, and solid waste. Not included are overly specific studies, biological effects, or studies not applicable to more than one plant. (GRA)

1973

COM-73-11741/RGA PC\$20.00/MF\$20.00
National Technical Information Service, Springfield, Va.
ENERGY. A BIBLIOGRAPHY OF SELECTED
U.S. GOVERNMENT R AND D ACTIVITY.
1973. 40p* NTIS-BIB-73-01

Descriptors: (*Energy, *Bibliographies), Electric power generation, Fuels, Fuel consumption, Supply(Economics), Demand(Economics), Government policies, Air pollution, Water pollution.

This annotated bibliography of selected abstracts of research reports on energy was created using the NTIS on-line computer retrieval system-NTISearch. The bibliography is divided into four sections covering the following topics: General Energy Studies; Fuels; Energy Use, Supply, and Demand; and Power and Heat Generation. The section on fuels is further divided into two parts: supply and demand; and abstracts involving sources and production of selected fuels.

1972

Indexed Bibliography of Thermal Effects Literature-2—
This report is a compilation and annotated bibliography of information previously published in technical literature on the subject of thermal discharges from power plants and its interaction with aquatic ecology. Includes an author index, keyword index, abstracts, and the QUIC title index. Engineering aspects of thermal effluent control are covered including literature on discharge modeling, cooling towers, and beneficial effects. Ecological references include temperature effects on fish and other aquatic animals both in fresh and salt water. Actual site surveys around power plants are covered as well as environmental impact statements. 1972. 278 pp. PC \$10/MF \$10 order ORNL-NSIC-97/G

TITLE: Man and the Environment. A Bibliography of Selected Publications of the United Nations System 1946-1971

AUTHOR: Winton, R.W. (Ed.)

CORPORATE AUTHOR: United Nations, Dag Hammarskjöld Library

ADDRESS: New York, NY

PUBLICATION DESCRIPTION: Unipub, Inc./R.R. Bowker Co., 1180 Avenue of the Americas, New York, NY 10036, 305 p.

PUBLICATION DATE: 1972

ABSTRACT: The purpose of this bibliography is to call attention to the types of information and publications produced by United Nations organizations. The book contains references to more than 1200 publications on a variety of subjects including: environment; natural resources; earth sciences; mineral, fuel, and energy resources; water, plant, and animal resources; food production, standards, hygiene, processing, and additives; population; health; air and water pollution; and waste disposal. (NPG)

AVAILABILITY: (\$12.50)

N74-19228 Environmental Protection Agency, Research Triangle Park, N.C. Air Pollution Technical Information Center.
AIR POLLUTION ASPECTS OF EMISSION SOURCES: PETROLEUM REFINERIES: A BIBLIOGRAPHY WITH ABSTRACTS

Jul. 1972 73 p refs

(AP-110) Avail: SOD HC \$1.25

Selected abstracts are presented of articles concerning air pollution by petroleum refineries. Subject and author indexes are included. Author

1971

N74-16642 Committee on Interior and Insular Affairs (U. S. Senate).
A BIBLIOGRAPHY OF CONGRESSIONAL PUBLICATIONS
ON ENERGY FROM THE 89TH CONGRESS TO 1 JULY
1971

Dana C. Elingen, comp. and William E. Towsey, Jr., comp.
Washington GPO 1971 63 p. refs. Presented to Comm. on
Interior and Insular Affairs, 92d Congr., 1st Sess., 5 Nov. 1971
Avail: Comm. on Interior and Insular Affairs
A bibliography of Congressional Publications on Energy
Resources and Requirements is presented. The documents cover
the period of time from 1 January 1965 to 30 June, 1969.
The subjects included in the bibliography are: (1) national energy
goals, (2) energy policy issues, (3) projections of future demands,
(4) resource base for all types of energy sources, (5) management
of federally owned resources, (6) production of fuels (including
storage), (7) transportation of energy and fuels, (8) utilization
(including conservation measures), (9) environmental effects, (10)
research and development of resources, and (11) changing and
improving regulatory practices.
P.N.F.

N74-16641 Committee on Interior and Insular Affairs (U. S. Senate).
A BIBLIOGRAPHY OF NON-TECHNICAL LITERATURE ON
ENERGY
Flora Dean, comp. Washington GPO 1971 104 p. refs
Presented to Comm. on Interior and Insular Affairs, 92d Congr.,
1st Sess., 5 Nov. 1971 Prepared by Library of Congr.
Avail: Comm. on Interior and Insular Affairs

A bibliography of non-technical literature on energy sources
and problems was prepared for the Committee on Interior and
Insular Affairs of the United States Senate. The reports cover
the period of time from 1 July 1969 to 1 July 1971. The
subjects covered include the following: (1) national energy goals,
(2) energy policy issues, (3) projections for future demands, (4)
resource base for all energy sources, (5) management of federally
owned resources, (6) production of fuels, (7) transportation of
energy and fuels, (8) utilization (including conservation measures),
and (9) environmental effects (relation of environmental policy
to energy policy).
P.N.F.

74N71119 CIRC-641 70/00/00 24 PAGES UNCLASSIFIED DOCUMENT
SELECTED SOURCES OF INFORMATION ON UNITED STATES AND WORLD ENERGY
RESOURCES - AN ANNOTATED BIBLIOGRAPHY
A/AVERTT, P.; B/CARTER, M. D.
GEOLOGICAL SURVEY, WASHINGTON, D.C.
/*BIBLIOGRAPHIES/*ENERGY REQUIREMENTS/ COAL/ CRUDE OIL/
ELECTRIC POWER/ FLUID POWER/ GEOTHERMAL RESOURCES/ NUCLEAR ENERGY/
SOLAR ENERGY

1970

PB-197 386
Mitre Corp., McLean, Va.
A SURVEY OF FUEL AND ENERGY INFORMATION
SOURCES. VOLUME I,
D. L. Hobbs, E. L. Keitz, J. Morris, and K. E.
Yeager. Nov 70, 298p *MTR-1493-Vol-1
AFTD-0627
Contract F19628-68-C-0365
See also Volume 2, PB-197 387.

Descriptors: (*Information retrieval, *Organiza-
tions), (*Fuels, Information retrieval), (*Energy,
Information retrieval), Directories, Sources, Na-
tional government, State government, Air pollu-
tion, Trade associations, Technical societies,
Laboratories.
Identifiers: *Management information systems.

From 103 Federal, state, and independent infor-
mation source agencies surveyed, the total number
of fuel and energy related documents published is
over 40,000. In addition this volume identifies 77
unpublished Federal fuel and energy related
questionnaires which are circulated to 120,000 in-
dividual industrial corporations each year. The
fuel and energy information source agencies are
organized according to a set of management infor-
mation descriptors developed by the study.
(Author)

PB-197 387
Mitre Corp., McLean, Va.
A SURVEY OF FUEL AND ENERGY INFORMA-
TION SOURCES. VOLUME II. FEDERAL
QUESTIONNAIRES,
D. L. Hobbs, E. L. Keitz, J. Morris, and K. E.
Yeager. Nov 70, 631p *MTR-1493-Vol-2
AFTD-0628
Contract F19628-68-C-0365
See also Volume I, PB-197 386.

Descriptors: (*Information retrieval, *Organiza-
tions), (*Fuels, Information retrieval), (*Energy,
Information retrieval), Directories, Air pollution,
Sources, National government, Questionnaires.
Identifiers: *Management information systems.

The 77 unpublished Federal fuel and energy re-
lated questionnaires identified and described in
Volume I of this survey are reproduced. (Author)

ENERGY.

M.S. Macrakis, Ed.

MIT Press, Cambridge, Mass. 1974.

The book is based on a conference held at MIT in February 1973. It includes in their entirety three important invited papers—"Ways of Looking at Future Economic Growth, Resource and Energy Use," by Tjalling C. Koopmans; "Theory and Practice of Effluent Control," by Robert Dorfman; and "The Fuel Shortage and Thermodynamics-The Entropy Crisis," by Joseph H. Keenan, et al--and a number of contributed papers that were presented at the conference by authorities from across the country and from abroad. The papers are organized in the following groups; economic growth and energy resources, the modeling of the energy system, input-output methodologies applied to energy studies, institutional problems, problems of gas regulation, energy supply, studies of electrical demand, transportation energy, transportation of energy, and energy conservation.

N74-21619# Mitre Corp., McLean, Va.
BACKGROUND MATERIAL FOR THE ENERGY POLICY WORKSHOP, 11-12 JANUARY 1973

Richard S. Greeley Feb. 1973 79 p

(M73-12) Avail: NTIS HC \$7.00

A specific set of energy policies focused on achieving competitive fuel prices, increased domestic fuel supplies, and environmental protection is discussed. A set of charts containing background information on current and projected fuels availabilities and prices and a narrative discussion of each one is presented.

Author

N74-19615# Mitre Corp., McLean, Va.
ENERGY, RESOURCES AND THE ENVIRONMENT: A SET OF PRESENTATIONS

Richard S. Greeley Jun. 1973 79 p Presented at the US Inform. Agency Exhibit on Progr. and the Environ., Poland Intern. Trade Fair, Lodz. 18-22 Jun. 1973

(M73-61) Avail: NTIS HC \$7.00

The fuel resources available to the world are described, including solar, nuclear fusion, nuclear fission, geothermal, tidal, hydro, and fossil energy sources. These resources are compared with estimated fuel consumption rates in the future. Solar, fusion, and fission with breeding are shown to represent essentially infinite energy sources. Methods are described for improving the efficiency and economy in the ways we use fuels. Savings of 10-15% appear possible in the near term. An energy ethic is described which involves changes to government regulations and tax policies and other institutions to promote efficiency and conservation in the use of fuels. The technology of advanced energy systems is described including automobile engines, mass transit systems, pollution control devices, fuel cells, and magnetohydrodynamic production of electricity. The need for a vigorous, international research and development program is discussed to provide assurance for continued supplies of clean, abundant energy.

Author

N74-19717# Naval Ship Research and Development Center, Annapolis, Md.

PROCEEDINGS OF WORKSHOP ON NAVY ALTERNATE ENERGY SOURCES RESEARCH AND DEVELOPMENT

J. R. Belt, ed. and H. V. Nutt, ed. Jan. 1974 97 p refs Conf. held at Annapolis. 18-20 Sep. 1973

(AD-773746) NSRDC-4195) Avail: NTIS CSCL 21/4

A workshop was held to examine the Navy's energy requirements and the directions that Navy Research and Development should take to minimize the impact on the Navy of projected national petroleum fuel supply shortages. The current state of research and development on liquid fuels from coal and oil shale, as well as the ability to extract from them fuels that are reasonably similar to currently used petroleum products, make it appropriate for the Navy to concentrate first on these. Demonstrations of compatibility of Navy power plants with fuels derived from coal or oil shale, and definition of minimum fuel quality requirements, are needed. For the longer term, efforts to harness environmental energy sources, such as winds, currents, and thermal gradients in the earth and in the oceans, appear to have considerable potential payoff, particularly for nonmobile applications. (Modified author abstract)

GRA

Energy, Environment, Productivity, Proceedings of the First Symposium on RANN,
November 18-20, 1973. NSF 74-19.

(Contact NSF Office of Public Technology Projects,
Room 405, or RANN Document Center, Room 601,
1800 G.St., N.W., Wash., D.C. 20550.)

TK2896.I55 1973

A73-38396 Intersociety Energy Conversion Engineering Conference, 8th, University of Pennsylvania, Philadelphia, Pa., August 13-16, 1973, Proceedings and Addendum. Conference sponsored by AIAA, AIChE, ANS, ASME, IEEE, SAE, and ACS. New York, American Institute of Aeronautics and Astronautics, Inc., 1973. Proceedings, 854 p.; Addendum, 180 p. Members, \$50.; nonmembers, \$60.

The development of energy conversion systems is depicted in papers dealing with the operation, design, performance, materials, testing, and reliability of specific new and improved system concepts. Major topics covered include radioisotope thermoelectric generators, electrochemical power systems, solar power, biomedical power sources, nuclear energy, hydrogen fuel developments, Stirling cycle engines, aerospace power systems, and urban energy sources. Devices examined cover the wet Brayton cycle engine, Rankine cycle engines, the Wankel rotary engine, fuel cells, batteries, gas turbines, nuclear reactors, and utility systems for urban needs.

T.M.

Conference on World Energy Supplies.

London, England: Financial Times (1973), 1 + 263p. Conference held at: London, England. Date 18-20 Sept. 1973. The following topics were dealt with: the existing power resources, the power needs in 1980, availability of oil, nuclear power, solar power and geothermal energy. 25 papers were presented, of which all are published in full in the present proceedings. Individual papers within the scope of this journal will be covered in this or a subsequent issue.

ENERGY MODELLING: SPECIAL ENERGY POLICY PUBLICATION.
Papers presented at a workshop organized by the
US National Science Foundation & Energy Research Unit,
Queen Mary College, London, Oct.15-19,1973.
IPC Science & Technology Press, Ltd, Surrey,
England, 1974.

TJ5.A55 1973

Proceedings of the American Power Conference, Vol.35.
Chicago, Ill., USA: Illinois Inst. Technol. (1973), xlii + 1268 (\$20.00).
Conference held at: Chicago, Ill., USA. Date 8-10 May 1973. Sponsors:
Illinois Inst. Technol. The following topics were dealt with: nuclear plant
design, fast breeder reactors, updating nuclear plant operating experience,
nuclear plant standardisation, licensing and regulation, environment and safety
aspects of nuclear plants, large steam turbine generators, long-range power
generation, fuels and stack gas cleaning, power plant auxiliaries, gas turbines
and combined cycles, cooling systems, industrial plants, boilers, water condi-
tioning, reuse and reclamation of water, pumped storage operation, high voltage
laboratories, power transmission and environmental engineering. 128 papers
were presented, of which all are published in full in the present proceedings.
Individual papers within the scope of this journal will be covered in this or a
subsequent issue.

ENERGY AND THE ENVIRONMENT - Proceedings of the
1st Annual AIChE Southwestern Ohio Conference.
Amer. Inst. Chem. Engineers, 1973, N.Y.

N74-16685# Mitre Corp., McLean, Va.
ENERGY, RESOURCES AND THE ENVIRONMENT
Charles A. Zrakat 24 Oct. 1972 38 p. Revised
(M72-180-Rev-1) Avail: NTIS HC \$4.00

The proceedings of eight symposia on the subject of energy
resources and requirements are summarized. The subjects
discussed include the following: (1) the long term energy situation,
(2) the future outlook for energy and resources, (3) the international
context, (4) the intermediate situation or energy crisis, (5) options
for the long term situation, (6) transportation requirements, (7)
current problems with the environment, and (8) long term
environment impact factors.

Author

N74-18582 #

(CONF-720480-P1-R2) SYMPOSIUM ON ENERGY, RESOURCES, AND THE ENVIRONMENT. Session on International Issues. (MITRE Corp., McLean, Va. (USA)). 12 Apr 1972. 22pp. (M-72-69(Vol. 1)(Rev. 2)).

This report provides a transcript of the proceedings on the first day, April 12, 1972, of the symposium. Mr. Charles A. Zrakel, Senior Vice President, The MITRE Corporation, opened the session with a summary of the overriding issues identified and the conclusions drawn during the five preparatory meetings for the symposium. Mr. Robert B. Panero, Director of Economic Development Studies for Hudson Institute, presented a context for the session. Dr. Jay Forrester, Professor at the Massachusetts Institute of Technology discussed the results of his computer simulation of world dynamics and the implications for policy decisions. Dr. Herman Kahn, Director, Hudson Institute, presented an economic basis for energy and resource use to solve international societal problems in the future. Dr. Glenn Werth, Associate Director for Plowshare, Lawrence Livermore Laboratory, gave a review of world-wide energy demand and resources and technology for meeting that demand. Dr. Robert A. Chaple, President, Cabot Corporation, described the venture his company is making in importing liquefied natural gas from Algeria. The session closed with a question and answer period with all the speakers participating as a panel. (auth)

TITLE: World Energy Demands and the Middle East.

Part I

AUTHOR: Meyer, A.J.; Hubbert, M.K.; King, P.E.; Carlsmith, R.S.; Atkins, J.E.; Yamani, S.A.Z.
CORPORATE AUTHOR: Middle East Institute
ADDRESS: 1761 N St. NW., Washington, DC 20036
PUBLICATION DESCRIPTION: Proceedings of the 26th Annual Conference of the Middle East Institute, Washington, D.C., 105 p.

PUBLICATION DATE: 1972, September
ABSTRACT: Part I of the Conference Proceedings contains the keynote address: The Middle East and World Energy; papers presented on Panel I, Pressures of Energy Demands on Resources; Survey of World Energy Resources; Fossil Fuels; and Alternative Sources of Energy; and papers presented on Panel II, Prospects for Cooperation Between Oil Producers, Markets and Consumers; Evolving Relationships Among the Oil Companies; The Oil Producing Governments and Major Consumers; and Prospects for Cooperation Between Oil Producers, Markets and Consumers; The Issue of Participation and After. (NPG)

AVAILABILITY: Middle East Institute (\$3.75)

N74-18598 #

(CONF-720480-P3-R1) SYMPOSIUM ON ENERGY, RESOURCES, AND THE ENVIRONMENT. Session on Options for the Future and Their Resources, Economic, and Environmental Effects. (MITRE Corp., McLean, Va. (USA)). 14 Apr 1972. 198p. (M-72-69(Vol. 3)(Rev. 1)).

A transcript is provided of the proceedings on the third day, April 14, 1972, of the symposium. Monsieur Jean DeGroot, Director of Economic Research at Hydro-Quebec, opened the session and introduced the keynote speaker, Dr. Clarence E. Larson, Commissioner, U. S. Atomic Energy Commission. He presented a comprehensive set of technological developments which provide a wide range of options for the future. Dr. Masao Sakisaka, President of the Institute of Energy Economics of Japan, described the energy, resources, and environmental situation in Japan. Dr. William W. Kellogg, Director of the Laboratory of Atmospheric Sciences, National Center for Atmospheric Research discussed the impact of man's energy use on world climate. Mr. Lelan F. Sillin, Jr., President of Northeast Utilities and Member of the Citizens' Advisory Committee on Environmental Quality, spoke about some of his ideas for a major R&D program to meet the energy crisis. Mr. Keith Roberts, Consultant to the Sierra Club, presented the views of an environmentalist. Dr. Richard E. Balzhiser, Assistant Director for Natural Resources, Office of Science and Technology, discussed energy options that the Federal government is or should be pursuing. The session closed with a question and answer period with all the speakers participating as a panel. (auth)

N74-18591 #

(CONF-720480-P2-R1) SYMPOSIUM ON ENERGY, RESOURCES, AND THE ENVIRONMENT. Session on Ethics and Environmental Aspects of the Demand for the Use of Energy. (MITRE Corp., McLean, Va. (USA)). 13 Apr 1972. 252p. (M-72-69(Vol. 2)(Rev. 1)).

A transcript is provided of the proceedings on the second day, April 13, 1972, of the symposium. Dr. S. Fred Singer, Professor at the University of Virginia and formerly Deputy Assistant Secretary of the Interior, discussed national energy policy in terms of providing abundant, low-cost, clean energy. Dr. Marvin R. Gustavson, of the Lawrence Livermore Laboratory presented the need for development of a "consensual energy ethic." Mr. S. David Freeman of the Twentieth Century Fund, and formerly Director of the Energy Policy Staff in the Office of Science and Technology, discussed the issues involved in developing our energy and environmental ethic. Mr. John F. O'Leary, formerly Director, U. S. Bureau of Mines, presented a comprehensive set of energy, resource, and environmental issues and described some changes to governmental institutions for dealing with the energy crisis. Dr. Marc Roberts, Professor at Harvard University, explored three mechanisms for achieving cleaner power: prices, regulation, or direct public provision. Dr. Greeley, Associate Technical Director of the MITRE Corp., presented some environmental issues which had been raised in the previous meetings. The session closed with a question and answer period with all the speakers participating as a panel. (auth)

TITLE: World Energy Demands and the Middle East,
Part II

AUTHOR: Anthony, N.B.; Herter, C.A., Jr.;
Anthony, J.D.; Van Dusen, R.; Issavi, C.

CORPORATE AUTHOR: Middle East Institute
ADDRESS: 1761 N St. NW., Washington, DC 20036

PUBLICATION DESCRIPTION: Proceedings of the 26th
Annual Conference of the Middle East

Institute, Washington, DC, 57 p.

PUBLICATION DATE: 1972, September

ABSTRACT: Part II of the Conference Proceedings
contains resumes of four panel discussions:

Politics of Oil Demand and Supply; The
Economic and Political Impact of Oil upon the
Middle East and North Africa; Preparing for
Economic Diversification and Strengthening
Internal Political, Economic and Social
Strategies; Oil Haves and Have-Nots - Their
Relative Developmental Positions and
Relations between them. Also included are
the banquet and concluding addresses. (BPE)

AVAILABILITY: Middle East Institute (\$3.75)

QC603.P6 1972

A73-28581

Power Sources Symposium, 25th, Atlantic
City, N.J., May 23-25, 1972. Proceedings. Symposium sponsored by
the U.S. Army. Red Bank, N.J., PSC Publications Committee, 1972.
204 p. \$20.

Development efforts, design features, materials properties, and
performance evaluations are described for primary and secondary
battery systems, thermal energy conversion devices, solar cell arrays,
and fuel cells. Topics considered include battery degradation
mechanisms, charging and charge-maintenance systems, electric
power control and conditioning circuits, isotopic power systems,
fossil-fuel heated thermionic diodes, an organic Rankine cycle power
system, solar cell efficiency improvements, and advanced spacecraft
fuel cell systems.

TK2896.I55 1972

A73-22761
Internacody Energy Conversion Engineering
Conference, 7th, San Diego, Calif., September 25-29, 1972. Proceed-
ings. Conference sponsored by ACS, AIAA, ASME, IEEE, AICHE,
ANS, and SAE. Washington, D.C., American Chemical Society, 1972.
1543 p. Members, \$50; nonmembers, \$60.

Topics discussed include fuel-cell and battery technology;
silicon-germanium thermoelectric technology; life performance of
thermoelectric materials and generators; thermoelectric power gener-
ation and cooling; advanced prime movers; manned space power
systems; advanced unmanned spacecraft power systems; isotope
systems; reactor subsystems, power conditioning and computer
simulation; solar power technology; biomedical energy systems;
thermionic technology; military ground power; various advanced
power generation, propulsion, and energy transfer systems; nuclear
energy systems; and hydrogen energy systems.

TK2896.I54 1972

A74-20627
Power sources 4: Research and development in
non-mechanical electrical power sources; Proceedings of the Eighth
International Symposium, Brighton, Sussex, England, September
24-26, 1972. Symposium sponsored by the Joint Services Electrical
Power Sources Committee of England. Edited by D. H. Collins.
Newcastle-upon-Tyne, England, Oriel Press, Ltd., 1973. 606 p.
\$24.60.

Topics discussed include a lithium/sulfur battery, a reversible
negative electrode for alkaline storage batteries based on hydrides of
the Ti-Ni system, high-discharge-rate long-life nickel/zinc cells, a
bipolar Ni(OH)₂-K₂SO₄-Zn accumulator with a zinc ion repelling
separator, separators for silver/zinc alkaline cells, the effect of KOH
on sintered silver electrodes, a silver oxide/zinc battery, sintered
plate nickel hydroxide electrodes, a hot-pressing technique for
fabricating cadmium and nickel electrodes, a laser interferometric
method of measuring the current distribution at nickel and cadmium
electrodes, the thermal behavior of sealed nickel/cadmium batteries,
the nickel/cadmium cells used on the OAO spacecraft, a two-layer
oxygen electrode with a hydrophilic porous nickel layer and a
hydrophobic carbon layer, the electrochemical behavior of mixed
oxides in aqueous media, the use of charge-transfer complexes as
electrodes in rechargeable batteries, and a rechargeable lithium
nonaqueous battery which utilizes lamellar transition metal dichal-
cogenides as 'host' structures for cathodic nonmetals.

PROCEEDINGS OF THE EFFECTIVE ENERGY UTI-
LIZATION SYMPOSIUM, PHILADELPHIA, PENNSYLVANIA,
JUNE 8-9, 1972. Philadelphia: Drexel University (1972). 305p.
(CONF-720690--).

Fifteen papers dealing with various aspects of energy utilization
from developments to the problems confronting the utilities and
the consumer were presented. New effective energy utilization
aspects include societal and environmental costs. Systems now
designed will meet composite goals of energy efficiency, financial
return, resource conservation, peak load capability, and new
standards for environmental and social impact, aesthetics, and
public acceptability. (MCW)

(CONF-721234-) OUTLOOK FOR ENERGY CONFER-
ENCE, MINNEAPOLIS, MINNESOTA, DECEMBER 7-8, 1972.
(Upper Midwest Council, Minneapolis, Minn. (USA)). Dec 1972.
84p.

From Outlook for energy conference; Minneapolis, Minnesota,
USA (7 Dec 1972).

Nine papers were presented at the conference on energy in
Dec. 1972. Supply and demand, economics, the environmental
impact, alternative sources, and some governmental views are
presented. (MCW)

INTERNATIONAL SYMPOSIUM ON ENERGY, MAN, AND THE ENVIRONMENT, ZÜRICH, SWITZERLAND, FEBRUARY 3-5, 1972. Zurich: Gottlieb Duttweiler Institute (1972). 193p. (CONF-720234-). 60 Swiss Francs.

Papers presented were: energy and man; energy and the hydro-sphere; energy and business; present state and future development of traditional energy sources; energy trends in the United Kingdom; The ideological basis of planning; atomic energy—the future now?; energy and environmental protection: the dangers of nuclear power; atomic power and the environment: some problems encountered between design and construction; and the earth a dying planet? (MCW)

(BNL-50355) ENERGY, ENVIRONMENT AND PLANNING: THE LONG ISLAND SOUND REGION. Proceedings of a Conference held at Brookhaven National Laboratory, October 5-7, 1971. Goldberg, M. D. (ed.). (Brookhaven National Lab., Upton, N. Y.). 12 Oct 1972. Contract AT(30-1)-16. 177p. (CONF-711077-). Dep. NTIS \$3.00.

Twenty papers presented at the conference were: The National Context; Long Island in the Region; Energy in the Long Island Sound Region; The Nature and Flexibility of Energy Demand in the United States; The Ecological Effect of Energy: A Basis for Policy in Regional Planning; Current Knowledge and Research Related to Environmental Aspects of Energy Production; Biology of Long Island Sound; Circulation and Energy Balance in Long Island Sound; The Structure of Planning; Energy Planning in the Long Island Sound Region; Planning Options and Political Realities; How to Keep the Lights on at Least Until 1980; Options in Power Generation and Transmission; and Considerations Bearing on the Need for New Institutions in the Energy Planning Field. Panel presentations included papers on the utilities, the planning community, the legal community, the technical community, the public, and the news media. (JCW)

Energy Technology to the Year 2000: A Special Symposium published by Technology Review. Massachusetts Institute of Technology, Cambridge, Massachusetts. 1972. 48 pages. Paperback \$1.95.

N73-13726# Rochester Univ., N.Y.: Dept. of Mechanical and Aerospace Sciences.

FIFTENTH MEETING OF AFOSR CONTRACTORS AND GRANTEES IN PHYSICAL ENERGETICS. Moshe J. Lubin 1972 166 p refs Meeting held at Rochester, N. Y., 7-9 Jun. 1972

(Grant AF-AFOSR-1279-87)

(AD-748265; AFOSR-72-1707TR) Avail: NTIS CSCL 20/9 The purpose of the conference is to exchange the latest information on research in non-chemical energy sources, release mechanisms and conversion processes, especially in the areas of plasma physics and nuclear fusion. GRA

N74-18634# Kentucky Univ., Lexington. Coll. of Engineering. PROCEEDINGS: ENERGY RESOURCE CONFERENCE (2ND)

Aug. 1973 59 p Conf. held at Lexington, Ky., 24-25 Oct. 1972

(PB-224750/OGA; UKY-TR-70-73-CEED4) Avail: NTIS HC \$5.00 CSCL 10A

Recent available information on the rapidly changing energy resource picture, fuel policies and consumer demands is presented. Papers by knowledgeable government officials and industrial representatives are included. Topics covered include new developments in the extraction of natural gas and crude oil, interfuel conversion (coal to gas and oil, coal to gas by the Lurgi process, SNG and oil), the role of the Federal Government to insure an adequate, reliable energy supply, and the transmission and transportation of energy. GRA

PROCEEDINGS OF THE EFFECTIVE ENERGY UTILIZATION SYMPOSIUM, PHILADELPHIA, PENNSYLVANIA, JUNE 8-9, 1972. Philadelphia: Drexel University (1972). 305p. (CONF-720690-).

Fifteen papers dealing with various aspects of energy utilization from developments to the problems confronting the utilities and the consumer were presented. New effective energy utilization aspects include societal and environmental costs. Systems now designed will meet composite goals of energy efficiency, financial return, resource conservation, peak load capability, and new standards for environmental and social impact, aesthetics, and public acceptability. (MCW)

73V29490 1972 ISS 00 TJ153.C67 1972 333.80973 LC-72-602143

SUMMARY REPORT.

CORNELL WORKSHOP ON ENERGY AND THE ENVIRONMENT, 1972.
U.S. GOVT. PRINT. OFF., WASHINGTON, XXI, 177 P. ILLUS. 24 CM.
\$0.70 AT HEAD OF TITLE 92D CONGRESS, 20 SESSION. COMMITTEE PRINT.
"SPONSORED BY THE NATIONAL SCIENCE FOUNDATION, RESEARCH APPLIED TO
NATIONAL NEEDS (RANN) PROGRAM." "PREPARED FOR THE COMMITTEE ON
INTERIOR AND INSULAR AFFAIRS, UNITED STATES SENATE ... PURSUANT TO S.
RES. 45 A NATIONAL FUELS AND ENERGY POLICY STUDY." "SERIAL NO. 92-23."
LC POWER RESOURCES -- UNITED STATES -- CONGRESSES. ENVIRONMENTAL
POLICY -- UNITED STATES -- CONGRESSES.
ADDED N*US** UNITED STATES. NATIONAL SCIENCE FOUNDATION. CORNELL
UNIVERSITY. UNITED STATES. CONGRESS. SENATE. COMMITTEE ON INTERIOR AND
INSULAR AFFAIRS.
MAIN-MEET TRACE-CORP* CATLG BY-LC

74N70794 72/CO/00 361 PAGES UNCLASSIFIED DOCUMENT
NATIONAL GOALS SYMPOSIUM, PART 1
COMMITTEE ON INTERIOR AND INSULAR AFFAIRS (U. S. SENATE). AVAIL
COMM. ON INTERIOR AND INSULAR AFFAIRS
WASHINGTON GPO HEARING BEFORE COMM. ON INTERIOR AND INSULAR
AFFAIRS, 92D CONGR., 1ST SESS., 20 OCT. 1971
/*CONGRESS/*ENERGY POLICY/ EARTH RESOURCES/ ENERGY REQUIREMENTS/
FUEL CONSUMPTION/ NUCLEAR ENERGY/ SOLAR
ENERGY.

74N71305 71/CO/00 466 PAGES UNCLASSIFIED DOCUMENT
NATIONAL GOALS SYMPOSIUM, PART 2
COMMITTEE ON INTERIOR AND INSULAR AFFAIRS (U. S. SENATE). AVAIL
COMM. ON INTERIOR AND INSULAR AFFAIRS
WASHINGTON GPO HEARINGS BEFORE COMM. ON INTERIOR AND INSULAR
AFFAIRS, 92D CONGR., 1ST SESS., 20 OCT. 1971
/*CONGRESS/*ENERGY POLICY/*FUEL CONSUMPTION/ ECOLOGY/ ECONOMIC
ANALYSIS/ ENERGY REQUIREMENTS

1971

HD9545.E6

ENERGY, ECONOMIC GROWTH, AND THE ENVIRONMENT. Conference Held at Washington, DC, April 20-21, 1971. Schurr, S. H. (ed.). Baltimore: Johns Hopkins University Press (1973). 238p. (CONF-710471-).

The complex relationship between the use of energy, economic growth, and the quality of the environment is examined in eight papers. The economic growth is discussed by Heller and Compton offering their views regarding society's requirements to assure both social and biological survival. Sporn, Gonzalez, and MacDonald examine the effects of rising energy consumption on environmental quality and of regulations on the availability and cost of energy. Mason, Seaborn, and Boulding discuss possible institutional and technological means of meeting the increased demand for energy while achieving desirable environmental objectives as well. In an appendix, Darmstadter presents data on trends and patterns of energy consumption in the USA and the world. (MCW)

PROCEEDINGS OF THE NATIONAL ENERGY FORUM, WASHINGTON, DC, SEPTEMBER 23-24, 1971. Washington, DC: National Division of the U.S. National Committee of the World Energy Conference (1971). 229p. (CONF-710982-).

After a summary of the energy issues, energy industries (coal, electricity, natural gas, nuclear, oil) are discussed in individual talks: Energy financing is then considered in two talks (commercial bank and investment bank). After a talk on academic energy research and development, individual viewpoints are given by representatives of various government agencies (AEC, Interior, Environmental Quality Council, Emergency Preparedness Office, FPC, Economic Advisors Council, EPA). Finally, an extensive forum of questions and answers is included. (DLC)

TK2896.I55 1971

A71-38901 Society of Automotive Engineers, Intersociety Energy Conversion Engineering Conference, Boston, Mass., August 3-5, 1971. Proceedings. Conference co-sponsored by the American Chemical Society, the American Institute of Aeronautics and Astronautics, the American Society of Mechanical Engineers, the Institute of Electrical and Electronics Engineers, the American Institute of Chemical Engineers, and the American Nuclear Society. New York, Society of Automotive Engineers, Inc., 1971. 1374 p. Members, \$40.; nonmembers, \$55.

Papers covering new energy conversion techniques and equipment for spacecraft, automobiles, biomedical uses, underwater powerplants, and other applications. System designs and test data are given for solar cell arrays, Brayton-cycle spacecraft electric power systems, biomedical radioisotope thermoelectric generators, implantable fuel cells and piezoelectric converters, electric and internal-combustion automotive power systems, battery and fuel-cell underwater powerplants, fusion powerplants, and advanced fossil-

GROWING AGAINST OURSELVES: THE ENERGY-ENVIRONMENT TANGLE. P.F. ABLEMS, POLICIES AND APPROACHES. Eighteen papers were presented at the international colloquium on Electric Energy Needs and Environmental Problems held in Eindhoven, Netherlands on June 9-12 1971. The colloquium was organized by the John F. Kennedy Institute, Center for International Studies (their publications No. 6) and the Future Shape of Technology Foundation in the Hague. These papers deal with environmental problems inherent in power generation and policies developed in various countries toward possible solutions. Covered are electrical energy generating nuclear plants, air pollution, waste heat disposal, etc. Following is a list of titles and authors: Introduction (Opening Statement). By J.H. Krusinga. Politics of Environment and National Development: Basic Operations and Political Responses to Environmental Problems. By Dean Schooler, Jr. Energy Environment and International Integration. By Francis A. Beer. Electrical Energy Needs and Environmental Problems. Now and in the Future. Electrical Energy, Demand and Supply. By J.H. Bakker and J.J. Went. Discharge of Waste Heat. By K.J. Keller. Air Pollution from Combustion Products. By A.J. Elshout and H. van Duuren. Biological Effects of Cooling Water Discharge. By J.L. Kooten. Biological Effects of Air Pollution. By P.E. Joosting and J.C. ten Houten. Environmental Effects Specific to Nuclear Power Production. By J.A.G. Davids, J.A. Goedkoop and M. Muysken. Energy Needs for Environmental Problems: United States Policy. By J. Clarence Davies. III. Bases of the U.K. Policy for Electrical Energy Production. By Craig Sinclair. French Policy in the Electrical Energy and Environmental Fields. By J.M. Martin. Electrical Energy Needs and Environmental Problems in Poland. By Jack Janczak. Long Term Planning in Poland. By Pawel Jan Nowacki. American National Energy Policy? By Robert M. Lawrence. Contribution to Systems Analysis of Environmental Control. By Peter Jorg Jansen. Evaluation and Outlook. By S.L. Kwee. Davids, J.A.G.; Goedkoop, J.A.; Muysken, M.; Davies, J. Clarence III; Sinclair, Craig; Martin, J.M.; Janczak, Jack; Nowacki, Pawel Jan; Lawrence, Robert M.; Jansen, Peter Jorg; Kwee, S.L. *Grow Against Ourselves: The Energy-Environ Tangle* Available from Lexington Books, D.C. Heath and Co. Lexington, Mass. 1972. 252

73V16329 1973 ISS 00 TD195.E4S95 1971 0-816503-84-2 621.3121
LC-72-83559

ENERGY NEEDS AND THE ENVIRONMENT. EDITORS ROBERT L. SEALE AND
RAYMOND A. SIERKA.

SYMPOSIUM ON ENERGY, THE ENVIRONMENT, AND EDUCATION, UNIVERSITY OF
ARIZONA, 1971.

UNIVERSITY OF ARIZONA PRESS TUCSON, XIII, 349 P. ILLUS. 24 CM.
INCLUDES BIBLIOGRAPHICAL REFERENCES.

LC ELECTRIC POWER-PLANTS -- ENVIRONMENTAL ASPECTS -- CONGRESSES.
ELECTRIC POWER-PLANTS -- ENVIRONMENTAL ASPECTS -- UNITED STATES --
CONGRESSES.

ADDED N*US*** SEALE, ROBERT L., ED. SIERKA, RAYMOND A., ED.

MAIN-MEET TRACE-TITLE*AUTH* CATALOG BY-LC

Power sources
National Academy of Sciences
Proceedings, v.68, no.8, p.1919-1943 1971
Aug.

SYMPOSIUM ON ENERGY FOR THE FUTURE-PROBLEMS AND
PROSPECTS. (Presented at the annual meeting of the
NAS, Apr.1971).

National Academy of Sciences
Symposium on Energy for the Future - Apr.
Problems and Prospects 1971

Energy for the future--problems and prospects
Introductory remarks
Initiatives for the future of energy
Electric power from nuclear fission
Fusion power
Power generation and the environment

TK
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1970

International Symposium on Power Sources 3, Brighton,
ton, 1970.
Power sources 3; research and development in
non-mechanical electrical power sources. Proceedings.
Sponsored by the Joint Services
Electrical Power Sources Committee. Edited by
D. M. Collins. Newcastle upon Tyne, Eng.,
Oriel Press, 1971.
ix, 654 p. illus. 24 cm.

1970

1971

TK2896.I55 1970

A73-25976 Energy 70: Proceedings of the Fifth International
Society Energy Conversion Engineering Conference, Las Vegas, Nev.,
September 21-25, 1970. Volumes 1 & 2. Conference sponsored by
ACS, AIAA, AIChE, ANS, ASME, IEEE, and SAE. Hinsdale, Ill.,
American Nuclear Society, 1972. Vol. 1, 871 p.; vol. 2, 432 p. Price
of two volumes, \$40.

Recent developments in energy engineering are described in
papers dealing with fusion technology, Brayton-cycle systems,
electrochemical power sources, heat-transfer concepts, isotope heat
sources, solar-cell technology, Rankine-cycle systems, and thermo-
electric and thermionic conversion topics. Relevant areas of applica-
tion include manned and unmanned space missions, biomedical
devices, marine systems, and central and compact utility systems.
Environmental aspects of energy management are examined along
with some advanced new concepts in power generation, conditioning,
and distribution.

16

A71-13028 Power Sources Symposium, 24th, Atlantic City, N.J., May 19-21, 1970. Proceedings. Symposium sponsored by the U.S. Army. Red Bank, N.J., PSC Publications Committee, 1970. 228 p. \$15.

Contents:

Session on secondary batteries.

Nickel-cadmium batteries for the Orbiting Astronomical Observatory spacecraft-II (OAO). F. E. Ford and T. J. Henningsen (NASA, Goddard Space Flight Center, Greenbelt, Md.), p. 1-4. (See A71-13027 03-03)

Chemical analysis of nickel-cadmium electrodes. H. H. Kroger and A. J. Catotti (General Electric Co., Gainesville, Fla.), p. 4-6. (See A71-13028 03-06)

Design, testing and flight performance of the Mariner Mars 1969 spacecraft batteries. S. J. Krause (California Institute of Technology, Pasadena, Calif.), p. 7-10. (See A71-13029 03-03)

High energy density, long life Zn-AgO secondary battery 88-634 (AU. E. J. Sattelmire (U.S. Army, Electronics Command, Fort Monmouth, N.J.), p. 10-13.

Zinc as a secondary battery electrode. T. P. Dirks (Calvin College, Grand Rapids, Mich.), p. 14, 15.

Physical changes at lithium electrodes during charge-discharge cycling. D. E. Semones and J. McCallum (Battelle Memorial Institute, Columbus, Ohio), p. 16-19. (See A71-13030 03-03)

Solid state energy storage device. J. E. Oxley (Gould Ionics, Inc., Canoga Park, Calif.), p. 20-23. 6 refs. (See A71-13031 03-03)

Session on fuse power sources.

Solid electrolyte batteries with modified AgI electrolyte. D. M. Smyth, C. H. Tompkins, Jr., and S. D. Ross (Sprague Electric Research and Development Center, North Adams, Mass.), p. 24-28. 7 refs. (See A71-13032 03-03)

A new high energy density solid electrolyte cell with a lithium anode. A. A. Schneider, J. R. Moser, T. H. E. Webb, and J. E. Desmond (Catalyst Research Corp., Baltimore, Md.), p. 27-30. 9 refs. (See A71-13033 03-03)

Reserve battery electrodes using bonded active materials. T. J. Kilduff and E. F. Horsey (U.S. Army, Harry Diamond Laboratories, Washington, D.C.), p. 30-35.

A one-dollar power supply for proximity fuses. F. G. Turrill (U.S. Army, Harry Diamond Laboratories, Washington, D.C.) and W. C. Kirchberger (Globe-Union, Inc., Milwaukee, Wis.), p. 36-39.

Reserve battery requiring two simultaneous forces for activation. A. M. Biggar (U.S. Army, Harry Diamond Laboratories, Washington, D.C.), p. 39-41.

The fluidic generator - A new electrical power source. C. J. Campagnuolo and R. W. Gotton (U.S. Army, Harry Diamond Laboratories, Washington, D.C.), p. 42-45.

Session on thermal energy conversion.

Manpack thermoelectric generator. J. P. Angello and S. J. Shapiro (U.S. Army, Electronic Components Laboratory, Fort Monmouth, N.J.), p. 46-50.

Reciprocating Rankine cycle engine developments. E. F. Doyle, R. J. Raymond, and T. LeFeuvre (Thermo Electron Corp., Waltham, Mass.), p. 51-54. (See A71-13034 03-03)

Organic Rankine cycle power system performance and status. M. W. Reck and R. W. Niggemann (Sundstrand Corp., Rockford, Ill.), p. 55-61. (See A71-13035 03-03)

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Effect of requirement specification on implementation of a power processor. J. J. Bies and A. D. Schoenfeld (TRW Systems Group, Redondo Beach, Calif.), p. 123-128.

Simplified nonindissipative regulation using unconventional magnetic-amplifier techniques. E. T. Moore (Wilmore Electronics Co., Inc., Durham, N.C.), p. 128-131. (See A71-13046 03-03)

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Session on fuel cells.

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Oxide bronzes as possible catalysts for oxygen reduction in batteries and fuel cells. R. A. Fredlein and J. McHardy (Pennsylvania, University, Philadelphia, Pa.), p. 175-178. 11 refs. (See A71-13054 03-06)

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Evolution of replaceable hydrazine module as a basic building block. R. E. Salathe (Whiteley Industries, Inc., Melrose, Mass.), p. 204-207.

Optimization of hydrazine-air cells. K. V. Kordesch and M. B. Clark (Union Carbide Corp., Cleveland, Ohio), p. 207-210.

Hydrazine fuel cells. L. C. Hymes, J. E. Ward, and G. L. Reed (Allis-Chalmers, Greendale, Wis.), p. 210-213.

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Power generation and environmental change, symposium of the Committee on Environmental Alteration, American Association for the Advancement of Science, December 28, 1969. Edited by David A. Berkowitz and Arthur M. Squires. Cambridge, Mass., MIT Press, 1971.
xxiii, 440 p. illus. 24 cm.

Enormous increases in the demand for power throughout the world make it imperative to reduce the environmental hazards and pollution associated with power generation. This book discusses the effects that power generation has had on the land, the water, the air, and the biosphere. It reviews the technological means available for abatement and control of damaging environmental effects and describes power generation techniques that could prove more compatible with the environment.

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ENERGY NEEDS AND THE ENVIRONMENT. Seale, R. L.; Sierra, R. A. (eds.). Tucson, AZ: University of Arizona Press (1973). 358p.

Traditional political and scientific boundaries of the interrelated problems of energy and the environment are discussed in the book by representatives from government, the energy industry, and academia. The nineteen papers are: The Challenge of Energy Generation; Energy Resources for Power Production; Air Resources; Water Use and Management Aspects of Steam-Electric Generation; Central Station Energy Requirements; Transportation Energy Requirements; Air Quality Criteria, Water Quality Criteria; Present Fossil Fuel Systems and Their Emissions; Present and Future Airborne Emissions Control; Thermal Emissions Control; Present Reactor Systems and Their Emissions; Present and Future Radiation Processing and the Environment; Present and Future Radiation Levels; Development of Federal and State Air Quality Control Programs; Environmental Engineering for the Navajo Project.

University of California System and Air Pollution Research; and National Goals as described by Weinhold from the Office of Science and Technology in the United States. (auth)

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The economic and technical possibilities of 2 major programs which offer potential for development of the western region of Saudi Arabia are examined. The 1st of these relates to utilizing the natural gas which comes to the surface with the oil. This gas represents a valuable source of energy for industry, electric power generation, and water desalination. The 2nd relates to the possibilities for electric power generation, improved transportation, industrial development, and land reclamation which would result from the construction of a causeway from the east coast of Saudi Arabia to Bahrain and from Bahrain to Qatar. This dam would isolate the Gulf of Bahrain from the Arabian Gulf and create an artificial reservoir, the Dabhat Salwah. Solar evaporation would lower the water level within the reservoir and hydroelectric power could be generated with the head thus created.

73V30299 1973 ISS OC TUL23.L673 C-359203-00-4; C-399008-55-9 333-8
LC-73-77422

A/WOODBURN, JOHN H.
THE WHOLE EARTH ENERGY CRISIS; CLR DWINDLING SOURCES OF ENERGY, BY
JOHN H. WOODBURN.

PUTNAM NEW YORK, 195 P. ILLUS. 21 CM.
\$4.89 (LIB. BDG.)
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A/ROBINETTE, GARY D.
ENERGY AND ENVIRONMENT BY GARY C. ROBINETTE.
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 YORK. 240 P. ILLUS. 22 CM.
 \$5.95 HIS WORLD OF THE FUTURE SERIES BIBLIOGRAPHY P. 219-231.
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 S3 Lexington, Mass., Lexington Books [1973]
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Edited by John O'M. Bockris. New York,
Plenum Press, 1972.
xiii, 296 p. illus. 24 cm.

Electrochemistry of Cleaner Environments
is the only book which fully explores the
potential of electrochemical power. It offers
techniques crucial to the problems of ob-
taining a pure atmosphere and uncontami-
nated water. In this authoritative volume,
leading scientists discuss such topics as the
influence of the combustion of fossil fuels
on the climate, batteries for vehicle pro-
pulsion, and the hydrogen economy.

BROWN-OUT. The Power Crisis in America.
Rogers, W. New York: Stein and Day (1972). 300p. \$7.95.
The annual power shortages will continue and worsen if the con-
sumption of power is not controlled. There is little doubt that the
expansion of power production and consumption, which the utilities
insist is necessary to their economic well-being, and the uninter-
rupted growth of industrial capacity invite ecological disaster. The
predicament of the power companies—a predicament involving the
utilities themselves and the government—and the people whom
both are supposed to serve are discussed. (GCV)

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Richard P. Runyon. New York, Crown Publish-
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xvii, 189 p. 24 cm.

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ergy cannot be recycled and energy resources are being rapidly
depleted. Environmental problems are theoretically solvable:
pollution can be largely abated by the same science that created
industry, and substantial percentages of materials can be recycled.
The chapters in the book are: The Accelerating Power Crisis; Oil:
The Gathering International Dangers; The Futility of Our Natural
Situation and Strategy; Coal: The Source of Synthetic Fuels; The
External Sources of Power: Inaccessible or Insufficient; Our Atomic
Energy Program: Too Little Too Late; Nuclear Fusion: An "Ulti-
mate" Answer to Our Future Energy Needs; The Electrical Re-
quirements of a Nuclear Age: We're Unprepared; Population-
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Misconceptions About Power; A Comparison of Nations; The
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MINERALS YEARBOOK. 1970. VOLUME 2: AREA
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1972. 787 p. refs
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Volume II, Area Reports: Domestic, contains chapters covering
the mineral industry of each of the 50 States, the U.S. island
possessions in the Pacific Ocean and the Caribbean Sea, the
Commonwealth of Puerto Rico, and the Canal Zone. This volume
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employment and injuries.
Author (GRA)

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Engineering for resolution of the energy-en-
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xiii, 340 p. illus. 28 cm.

The report deals with the urgent nationwide
problem of power plant siting, assembling and
analyzing material previously unavailable in a sin-
gle convenient source. The report provides en-
gineers, environmentalists, legislators, and the
electric power industry with detailed background
information, policy considerations, and conclu-
sions and recommendations for mitigating the con-
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World energy supplies, 1961-1970. New
York, United Nations, 1972.
vi, 373 p. tables, 28 cm. (United
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papers. Series J, no. 15)
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73V15670 1972 ISS OC T0195.E4G76 C-669847-15-1 333.7 LC-72-79804
GROWING AGAINST OURSELVES. THE ENERGY-ENVIRONMENT TANGLE. PROBLEMS,
POLICIES AND APPROACHES. ED. BY S. L. KWEE AND J. S. R. MULLENDER. WITH
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M. ALTING VON GEUSAU. ENGLISH LANGUAGE CONSULTANT NANETTE GILMOUR.
SILJHOF, LEXINGTON BOOKS, LEIDEN, LEXINGTON, MASS., XIX, 252 P. 24

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74V34754 1971 ISS OC T0153.H65 C-871560-55-0 333.7 LC-78-177949

A/HOLDREN, JOHN P.

ENERGY: A CRISIS IN POWER, BY JOHN HOLDREN AND PHILIP HERRERA.

SIERRA CLUB SAN FRANCISCO, 252 P. ILLS. 21 CM.

\$2.75 THE SIERRA CLUB BATTLEBOOK SERIES, 4 PT. 1. ENERGY RESOURCES
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New energy technology--some facts and
assessments, by H. C. Hotte! and J. B. Howard.
Cambridge, Mass., MIT Press, 1971.
xi, 364 p. illus. 24 cm.

ABSTRACT: "The emerging 'energy crisis' in the
United States results from the conflict
between the nation's insatiable need to
consume energy at an ever-accelerating rate
and the opposing need to conserve resources,
both natural and fiscal. Assessing the
extent of the problem and recommending
solutions, a long-term project to which this
book makes important contributions, are vital
to a society and an economy that are
fundamentally dependent on energy production
and consumption. This report concentrates on
the technological status of energy and fuel
conservation processes in the United States.
It assesses the technical and economic
adequacy of existing and proposed processes
(and their consistency with developing
standards of environmental quality) and
suggests where additional effort is needed to
accelerate change. Unlike most studies, which
restrict themselves to an examination of a
single energy source or industry, this report
examines in turn most of the various methods
of energy production now in use or likely to
come into general use. This wholeness of
view allows the authors to make meaningful
comparisons between alternative proposals and
to devise integrated growth strategies.
Chapters are included on fossil fuel-to-fuel
conversion (gas from coal, oil from coal, tar
sands, and oil shale), nuclear power (present
technology, and thermonuclear fusion), and
central-station power from fossil fuel (with
material on combined gas-steam power cycles,
magneto-hydrodynamics, superconducting
generators, and fuel cells). In addition,
the book provides background information and
evaluations regarding other relevant topics,
among them energy transportation and storage,
thermal and sulfur dioxide pollution control,
the prospects for utilizing solar energy,
automotive power plants, and space heating
and cooling. (from the book jacket)

SOCIAL ORGANIZATION OF ELECTRIC POWER SUP-
PLY IN MODERN SOCIETIES. Sporn, P. Cambridge, MD:
Massachusetts Institute of Technology Press (1971). 154p.
\$6.95.

Four lectures given at the Massachusetts Institute of Technology
during 1970 and 1971 on private vs. public ownership of electric
power companies are presented and include information on elec-
tric power generation in the U. S. and other advanced countries.
Ideological considerations involved in the merits of private vs.
public power; technical competence and performance as influ-
enced by social organization; protecting the consumer and the
public interest; and future problems of electric energy supply
systems with possible developments in the U. S. for solving
these problems. (L.C.L.)

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viii, 144 p. illus. 30 cm.
Originally appeared as articles in the Sept.
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Energy resources of the earth.
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Energy and information.
Decision-making in the production of power.
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Energy flow in an agricultural society.
Energy flow in an industrial society.
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TJ153.M54

HOW WILL WE MEET THE ENERGY CRISIS? POWER
FOR TOMORROW'S WORLD. Millard, Reed. Tomorrow's World
Series. New York: Simon and Schuster, Inc. (1971). 190p.
\$4.29.

Programs directed to meeting the energy crisis are examined.
Discussions and information are presented in chapters on the
energy crisis, fuels for power without pollution, power from the
atom, safety of atomic power plants, new ways to deliver power,
miniature power plants, power from rivers, power from the sea,
power from the earth, and power from the sun. (J.R.D.)

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Vansant, Carl.
Strategic energy supply and national security.
New York, Praeger, 1971.
xiii, 135 p. illus. 25 cm.

The world's energy supply is inherently a strategic issue be-
cause of the inequitable distribution of resources—oil, coal, nu-
clear, hydraulic—and increasing technological demands for power.
This book deals with this strategic aspect, provides a comprehen-
sive overview of energy supplies around the world, and assesses
the strength of the various nations from this perspective. The
international aspects of energy discovery, development and use
are discussed. Potential problems and new directions for tech-
nological exploitation are enumerated. (auth)

HC
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Power, pollution, and public policy: issues in electric power production, shoreline recreation, and air and water pollution facing New England and the Nation. Dennis W. Ducasik, editor. Cambridge, Mass., MIT Press [1971] xiii, 322 p. 26 cm. ([Massachusetts Institute of Technology. Sea Grant Project Office]. Report no. MITSG 71-8) (MIT report no. 24) "Index no. 71-108-C13."

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Darmstadter, Joel, 1928-
Energy in the world economy: a statistical review of trends in output, trade, and consumption since 1925, by Joel Darmstadter, with Perry D. Teitelbaum and Jaroslav G. Polach. Baltimore, Published for Resources for the Future by the Johns Hopkins Press [1971] x, 876 p. illus. 29 cm.

ABSTRACT: The book has three main objectives. First, to assemble the statistical data of the production, trade, and consumption of the energy resources of the world. Second, to evaluate these data and derive from them significant patterns and trends. Third, to relate these trends to other economic variables and thus provide a sound basis for future predictions. Several obvious conclusions can be drawn from the data presented: the world's fuel base is gradually converting from coal to oil, and patterns of strong interdependence between regions are developing. The five parts contain the following: a description of the significant findings; a series of significant statistical profiles; detailed statistics; a description of the methodology; and supplementary material including a brief bibliography.

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Mineral facts and problems, 1970. Washington, U. S. Dept. of the Interior, Bureau of Mines, 1970. vii, 1291 p. illus. 27 cm. (its Bulletin 650)

1. Mines and mineral resources--United States.
2. Mineral industries--United States. 1. Title. 11. Series: United States. Bureau of Mines. Bulletin 650.

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Odum, Howard T
Environment, power, and society [by] Howard T. Odum. New York, Wiley-Interscience [1970, 1971] ix, 331 p. illus. 24 cm.

1. Ecology.
2. Human ecology.
3. Force and energy. I. Title.

A71-11183 Direct energy conversion. M. A. Kertani (Pittsburgh, University, Pittsburgh, Pa.), Reading, Mass., Addison-Wesley Publishing Co., Inc., 1970. 466 p. 1376 refs. \$14.95.

The general aspects of energy conversion are briefly reviewed. Physical principles are then discussed in terms of thermodynamics, quantum mechanics, solid state, and plasma physics. Nine separate methods of converting energy directly are treated in detail. They include fusion power, magnetohydrodynamic, thermoelectric, and thermionic power generation, fuel cells, and electrohydrodynamic, piezoelectric, and ferroelectric power generation. Moreover, more than fifteen additional methods of converting energy directly into electricity are described in less detail.

O.H.

73V11525 1969 ISS OC TN15.553 553 LC-76-89702 LANGLEY L-43169-002
A/SKINNER, B. J.

EARTH RESOURCES

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CONSUMPTION/ EARTH RESOURCES

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74V38146 1969 ISS OC TP218.D37 1549 0-CEC139-47-7 662.6 LC-79-81796
A/DAVIES, E. N.

FUELS AND POWER, BY E. N. DAVIES AND S. A. JOHNSON.

1ST ED. PERGAMON PRESS OXFORD, NEW YORK, 157 P. ILLUS., MAPS. 25

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SUPPLY AND DEMAND FOR ENERGY IN THE UNITED STATES BY STATES AND

REGIONS, 1960 AND 1965: INTEGRATED ENERGY BALANCES AND ENERGY FLOWS

(PREPARED FROM FOUR PARTS), BY R. F. ZAFFARANO AND OTHERS.

UNITED STATES. BUREAU OF MINES.

FOR SALE BY THE SUPT. OF DOCS., U.S. GOVT. PRINT. OFF., WASHINGTON;

IV. 546 P. ILLUS., MAPS. 27 CM.

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IN 4. V. INCLUDES BIBLIOGRAPHIES.

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STATES -- STATISTICS. GAS, NATURAL -- UNITED STATES -- STATISTICS.

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ADDED ZAFFARANO, RICHARD F.

MAIN-CORP TRACE-SERS*TITLE*AUTH* CATALOG BY-LC

72V16501 19-- ISS OC TJ147.148 1968 621.4 LC-68-5715
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 ENERGY FOR MAN; WINDMILLS TC NUCLEAR POWER.
 GREENWOOD PRESS, NEW YORK, 409 P. ILLUS. 22 CM.
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72V20289 1968 ISS OC TP317.67165 C-340028-67-X 338.473337
 LC-68-113568
 A/TOMALIN, MILES.
 THE ENERGY MEN WHAT'S GOING ON IN FUEL AND POWER; CHAPTER OPENINGS
 BY QUENTIN BLAKE. OTHER ILLUSTRATIONS BY CHRISTINE MALONE AND RICHARD
 LEWIS.
 HODDER & STOUGHTON, LONDON, 190 P. ILLUS. 20 CM.
 25/- ZENITH BOOKS
 LC FUEL -- GREAT BRITAIN. POWER RESOURCES -- GREAT BRITAIN.
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72V25812 1967 ISS OC TJ153.C57 621 LC-68-101806
 A/CODAIS, NORMAN.
 ENERGY AND POWER, WITH DRAWINGS BY LASZLC ACS.
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 15/- THE YOUNG ENGINEER SERIES BIBLIOGRAPHY P. 119.
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 / / PUBL IN UNITED

Resources for the Future.

HC
 106.5
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 Resources in America's future; patterns of
 requirements and availabilities, 1960-2000, by
 Hans H. Landsberg, Leonard L. Fischman, and
 Joseph L. Fisher. Baltimore, Published for
 Resources for the Future by the Johns Hopkins
 Press, 1963.

xx, 1017 p. illus. 26 cm.
 1. Natural resources--U. S. 1. Landsberg,
 Hans H. II. Title.

621.1992

ENERGY IN THE FUTURE.
 P.C. Putnam.
 Van Nostrand Co., N.Y. 1953
 (out of print 1970).

Available from Naval Research Lab.

B. RESOURCES, SUPPLY/DEMAND, AND FORECASTING

THE ENERGY CRISIS. REFLECTION AND PERSPECTIVE - PART 1, REFLECTION.

W.R. HOLM.

J.SMPTE, v.83, no.2, Feb.1974, p.81-2.

Suddenly there are shortages, imminent or actual, of almost every source of energy needed to keep our economy functioning. We have, or we foresee, shortages of electrical power and of gasoline, heating oil, propane and other fuels—all of which are produced by or derived from petroleum. Moreover, we face shortages or projected shortages of plastics, petrochemicals, and other essential materials which are also derived from oil. As a result, we are beginning to realize that no other crisis in recent years has portended such a drastic effect upon industrial-nation economies as this energy crisis — not gold crises, not import-export crises, not labor crises — nothing.

THE ENERGY CRISIS. REFLECTION AND PERSPECTIVE - PART 2, PERSPECTIVE.

W.R. HOLM.

J. SMPTE, v.83, no.3, Mar.1974, p.220-223.

Undoubtedly we Americans will have to forget our old free-and-easy habits of power usage, at least until we can get much more of our energy from some source other than oil. But if we will grin and bear it, we can and must fashion a new declaration of independence. For this land is blessed with tremendous energy resources; and if American enterprise and American technology are unabashed, we will be free of all threats and all energy constraints imposed by other nations for whatever purpose and with whatever motive.

U. S. ENERGY SELF-SUFFICIENCY: VAIN HOPE OR ATTAINABLE GOAL? Roddis, L. H. Jr. Consolidated Edison Co. of New York, N.Y. Pub. Util. Forum, 193: No. 4, 24-27(14 Feb 1974).

The Arab oil embargo caused the precipitation of the fuel crisis, but the relief of this embargo is not a solution to the ever-approaching fuel problem. In attempting to attain U. S. energy self-sufficiency, four time frames are discussed. In the immediate year, conservation, allocation, and rationing should reduce the demand side. The second or near term in the 1970's must include increasing production of known wells, drilling in known regions such as Alaska, and finding ways to assure that known technologies of making clean-burning fuels from coal are applied at any cost. In the longer term to the year 2000, nuclear power and research and development for using coal, geothermal, and solar energy are necessary. In the very long term, development of nuclear fusion and the implementation of geothermal and solar energy are needed. (MCW)

ENERGY CRISIS: SOME CAUSES AND EFFECTS. Part

1. International Monetary Considerations. Merrietta, H. S. (Univ. of Dallas, Irving, TX). World Oil, 178: No. 2, 33-37; 48 (1 Feb 1974).

The relation of international monetary considerations to the energy problem is presented in-depth. International trade, balance of payments, U. S. dollar devaluations, the conversion of money in France to gold, all involve the international monetary system. The workings of the system are discussed and it is made clear that international oil cannot be debated without considerations of the monetary system. Slowest of all in coming to grips with the international monetary implications of world oil trade was the United States. (MCW)

ENERGY CRISIS: SOME CAUSES AND EFFECTS. Part 2. A Look at the Domestic Petroleum Situation. Mettelstein, H. A. (Univ. of Dallas, Irving, TX). World Oil, 178: No. 3, 43-44; 47-48; 51; 52; 54; 56(15 Feb 1974).

Basic economic laws are applied for an attempt to explain the domestic oil situation. How supply and demand relate to pricing and production; how government manipulation of taxation affects industry supply; what tax incentives really accomplish; why price controls are grossly counterproductive; and the role of so-called windfall profits in petroleum economics are discussed. (MCW)

WORLD ENERGY RESOURCES AND DEMAND

J. DAMSTADTER AND S. H. SCHURR

The world energy outlook to the mid-1980s: the effect of an alternative supply path in the United States

413

CONVENTIONAL PRIMARY ENERGY RESERVES: REVIEW AND DISCOVERY POTENTIAL (WORLD-WIDE)

D. C. ION

General problems of collecting and understanding world energy data

431

G. ARMSTRONG

World coal resources and their future potential

439

SIR ERIC DRAKE

Oil reserves and production

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C. P. COPPACK

Natural gas

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K. R. VERNON

Hydro (including tidal) energy

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S. H. U. BOWIE

Natural sources of nuclear fuel

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T. LEARDINI

Geothermal power

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FUTURE BALANCE OF ENERGY RESOURCES

G. B. R. FEILDEN, F.R.S.

Looking ahead

611

ENERGY CRISIS: SOME CAUSES AND EFFECTS. Part 3. A Look at International Oil, the OPEC Cartel, and Windfall Profits. Merrifield, H. A. (Univ. of Dallas, Irving, TX). World Oil, 178, No. 4, 47-52; 73 (Mar 1974).

Domestic demand-and-supply conditions, including taxation levels, affect the price and total sales of oil in the USA. New oil sources are costly to produce and shipping foreign-produced oil to the US and presence or absence of competition among international suppliers. Oil company windfall profits result from the interplay of foreign cartel prices and U. S. production costs. It is thought that prices will never come down to pre-embargo levels. And after the current political embargo, there will be a partial economic embargo. It is certain that OPEC members need to come to grips with American and European alternatives for energy production. The energy outlook is grim, not only now, but for decades to come. The wealth decline of the western world will be felt in food, clothing, travel, education, leisure. Policy mistakes have contributed to, and continue to contribute to, the current energy dilemma. (No references) (MCW)

ENERGY PINCH: LOOKING BEYOND END OF EMBARGO.

U.S. News & World Rept., Mar.25,1974, p.20,21.

No gas rationing, less worry about summer vacations, a boost for business--that's what an end to the embargo means. But a return to the 'good old days' is not in sight.

THE ENERGY CRISIS: IS IT FABRICATION OR MISCALCULATION?

E.I. Shaheen.

Environmental Sci. & Tech., v.8, no.4, Apr.1974, p.316-320.

Solutions to the shortage range from foreign oil to investigation of domestic resources.

ENERGY SITUATION: HOW WE GOT THERE--WHERE WE'RE GOING.

O.N. Miller.

Chem. Eng. Prog., v.70, no.5, May 1974, p.21-25.

We will have to change our attitude permanently toward this now precious commodity that is energy; anew ethic will have to arise that recognizes its importance and value.

ENERGY--THE NEW OUTLOOK.

C.C. Garvin, Jr.

Chem. Eng. Prog., v.70, no.5, May 1974, p.30-33.

In addition to capital to finance research and development of energy, we face another equally challenging need--the need for a greater number of trained engineers.

THE ENERGY CRISIS IN THE UNITED STATES.

G.C. Gambs.

Materials Performance, v.13, no.3, Mar.1974, p.27-28.

Energy crisis in the United States: Do you ever contemplate what could happen unless we change our direction? If government leaders heed our advice and act in time, then many anticipated problems may be avoided.

STATISTICS OF ENERGY, 1967-1971. Paris: Organization for Economic Cooperation and Development (1974). 257p. (In English and French). \$6.75.

A set of basic statistics on production, trade, consumption, etc. for each source of energy are assembled in the manual for economists and others concerned with energy problems in the OECD countries. Part One shows trends for each principal source of energy from 1967 to 1971 for the OECD as a whole and for each of the three main OECD areas. Part Two relates to the situation in 1969, 1970, and 1971 for all sources of energy in each OECD country and in the five groups of OECD countries. (MCW)

FUTURE TRENDS IN ENERGY SUPPLY. Hansen, L. G. Pub. Util. Fortn.: 93: No. 2, 24-28(17 Jan 1974).

Energy forecasts indicate a continuing growth rate in the consumption of energy in the USA economy. The energy source that is available domestically in the period 1974-2000 is graphically shown and indicates with proper planning that imported energy could be avoided. The resource base is identified as the quantity of energy that can be produced over a given period of time, rather than expressed as total resource base in the ground. The resources studied included coal, natural gas, petroleum, and uranium ores. Such actions as nuclear power plant moratoriums, banning space-heating electricity, the strip mining of coal, and delaying tactics in construction of new generating plants are the policies that precipitate a crisis. By utilizing present technology, about 70% of the present energy demands could be met by the use of electricity, thus reducing dependence on natural gas and oil. (MCW)

OUR ELECTRICAL FUTURE: WILL EPRI MAKE A DIFFERENCE. Balzhiser, R. E. (Electric Power Research Inst., Palo Alto, CA). Pub. Util. Fortn.: 93: No. 1, 23-27(3 Jan 1974).

Oil and gas have supplied almost half of the electrical energy in recent years. Both are in short supply now, and the author feels a more reasonable and realistic position must be adopted on the use of coal and nuclear power, but both have been plagued by environmental and safety concerns. The present technology is conversion is discussed. The role that the Electric Power Research Institute can play in the overall national effort for electrical production by serving as a coordinator in the industry's collective efforts is discussed. (MCW)

(COO-2399-1) ELECTRICAL POWER GENERATION IN WISCONSIN: THE CHALLENGE OF MEETING PRESENT NEEDS AND FUTURE DEMANDS. Final Report, March 1, 1973-February 28, 1974. Lee, L. R. (Wisconsin Academy of Sciences, Arts and Letters, Madison (USA)). 1974. Contract AT(11-1)-2309. 63p. Dep. NTIS \$6.25.

Six symposia covering Electrical Power Generation in Wisconsin: the Challenge of Meeting Present Needs and Future Demands were held during the 1973-74 school year. Each symposium was held in a different area of the state. A generalized program included: Environment Costs and Trends of Energy Use; Energy and Wisconsin - Today and Tomorrow; and Power Sources for Electricity - Promises and Problems. (MCW)

Projected Availability of Motor Gasoline and Distillate Fuels 1975-1985. Bonner and Moore Associates Inc Houston Tex 15 Jan 74, 104p RGH-042

AD-775 859/2WE PCS4.50/MF\$1.45

The project involved the preparation of forecasts for raw materials availability and product demands for the US refining industry through 1985 and the construction of a mathematical model of the industry. The major objective was to conduct an economic projection of the availability and compositional trends for automotive gasolines and distillate fuels during the next decade. Four major product demand forecasts (scenarios) were prepared and used to examine the industry. Additionally, the availabilities of jet and diesel fuels were examined in 1985 under two alternate premises. (Author)

ENERGY RESOURCE DEVELOPMENT FOR THE WEST. Wilkinson, L. E. Lakewood, CO: Western Interstate Nuclear Board (1974). 67p.

The principal findings and conclusions of the Western Interstate Nuclear Board's Energy Committee are reported on its study of energy resources, demands, consumption, and related topics. Contemporary and potential energy sources were examined and analyzed for near-term, transitional, and long-term. The report covers the total energy production and consumption for 1971 with emphasis on the electrical generation needs of the West. The results state how the West can assist in developing a new national energy pattern and become a net exporter with respect to energy in all forms. 76 references. (MCW)

1974

EXXON USA, First Quarter, 1974, v.8, no.1.

16 UNDERSTANDING THE NATIONAL ENERGY DILEMMA

A report by the Center for Strategic and International Studies

shows where energy comes from and how we use it.

Chen by CSIS

Science, v.184, no.4134, Apr.19, 1974.

A Timetable for Expanded Energy Availability: *A. L. Hammond* . . .

. 367

Energy Choices That Europe Faces: A European View of Energy: *W. H. Hilde* .

360

THE U.S. ENERGY SITUATION.

R.M. Develin and G.C. Meter.

Energy Sources, v.1, no.2, 1974, p.141-162.

WHY WORRY ABOUT FUTURE ENERGY NEEDS.

H. Johnson.

New Scientist, Mar.7, 1974, p.620-621.

By meeting energy needs now with population control and the exploitation of safe fuels our species will survive --if not, we and other life on Earth will face our doom.

ENERGY IN THE PEOPLE'S REPUBLIC OF CHINA.

G.C. Dean. p.33-

ENERGY SUPPLIES - A TEMPORARY CRISIS OR A PERMANENT PROBLEM? (A discussion)

p.67-

WASHINGTON REPORT: THE REAL CRISIS AND SELF-SUFFICIENCY BY 1980.

R. Corrigan. p.71-

Energy Policy, v.2, no.1, Mar.1974.

THE ENERGY OUTLOOK: WAYS TO GO.

R.K. Jurgen and G.D. Friedlander.

IEEE Spectrum, v.11, no.3, Mar.1974, p.83-87.

The issues are complex; the solutions not obvious. Both conservation and inspiration will play key roles.

Nature, v.249, June 21, 1974, p.697-98.

How Britain is facing the energy problem

"Our energy strategy must be flexible, balancing between different fuels and different sources, steering between overcaution and recklessness." Mr Eric Varley, Secretary of State for Energy, gives his view of the situation.

Nature, v.249, June 21, 1974, p.706-708.

Japan and the energy crisis

Takashi Mukaiibo

Faculty of Engineering, University of Tokyo, Japan

The central problem facing Japan is how to reduce her growing reliance on imported oil.

Nature, v.249, June 21, 1974, p.708-710.

Europe in turmoil finds time to discuss energy

Edward Phillips

Nature, 4 Little Essex Street, London WC2R 3LF, UK

Compared with the United States, which imports only a few per cent of its total energy needs, and the Soviet Union, which is a net exporter of energy, Europe is heavily dependent on outside supplies.

Nature, v.249, June 21, 1974, p.710-712.

Energy problems facing India

Narender K. Sehgal

465-R Model Town, Jullundur 144003, Punjab, India

If India is to avoid the worst effects of the increases in the price of oil she must make better use of her indigenous sources of energy.

Nature, v.249, June 21, 1974, p.712-714.

Soviet thoughts on energy resources

Vera Rich

London, UK

Nature's Soviet Correspondent shows that the Soviet Union is not being complacent about possible energy problems, large though her resources may be.

(CONF-740214-2) ENERGY DEMAND ANALYSIS
AND FORECASTING. Kaplan, S. L. (Oak Ridge National Lab.,
Tenn. (USA)). [nd]. 10p. Dep. NTIS \$3.00.
From conference on energy conservation research, Warrenton,
Virginia, USA (18 Feb 1974).

Energy demand by 12 major industries of the economy is
studied. The companies used nearly two-thirds of the energy con-
sumed in all manufacturing processes in 1971. The consumption
pattern for electricity and the various sources of thermal energy
over the past decade for each industry are recorded. Changes in
manufacturing processes that resulted in the energy use patterns
are noted. An evaluation was made of the most promising al-
ternative strategies open to industry management as it struggles
with rising costs of energy and raw materials. These take the
form of internal conservation of energy usage by eliminating
energy leaks and making more efficient use of the energy content
of waste streams. Energy consumption for 1971 was calculated
for industrial chemicals; blast furnace and basic steel products;
petroleum refining; paper mills; paperboard mills; hydraulic
cement; plastic materials and synthetics; primary nonferrous
metals; glass or glassware; flat glass; concrete, gypsum, and
plaster; and motor vehicles and equipment. (MCW)

ENERGY INFORMATION: Hearings before
the Senate Committee on Interior and
Insular Affairs regarding S.2782, a
bill to establish a national energy
information system which would auth-
orize the U.S. Dept. of Interior to
undertake an inventory of U.S. energy
resources. 1443 pages. (Serial No.
93-94 (92-69)), Parts I,II,III avail-
able from Committee on Interior and
Insular Affairs, U.S. House of Repre-
sentatives, Wash., D.C. 20510.)

Technology Review, v.76, no.6, May 1974, p.27-

Two: Energy Supply and Demand in 1980

When trade takes place with foreign suppliers, the
price of energy can never rise above the price at which
supply would equal demand if only domestic supplies
were available, since importation from abroad must
add some quantity to supply, and thus reduce the price.
Therefore, we ask how high the price may be for ex-
clusively domestic supply-demand equilibrium, since
the answer to this question provides a first indication
of the "cost" of security.

(UCID-16428) ELEMENTS OF THE WORLD ENERGY
CRISIS. Werth, G. C.; Green, E. (California Univ., Livermore
USA). Lawrence Livermore Lab., 14 Jan 1974. Contract W-
7405-eng-48. 31p. Dep. NTIS \$4.75.

The chain of events leading to the world energy crisis is fol-
lowed for each industrialized country and the effects that energy
shortages are presenting and options that are available are
identified. The Soviet Union has extensive oil and gas reserves
and the USA has extensive fossil fuel reserves, but needs to
develop technology for coal and shale. Western Europe has been
dependent upon Middle East oil, but could develop their coal
resources. Japan is dependent upon oil imports, and with the
advanced prices of oil, the capital on that island needs to be used
internally in improving living conditions. (MCW)

ENERGY SHORTAGE: A BENIGN CRISIS. Armstrong,
E. L. Consult. Eng. 42: No. 3, 112-116(Mar 1974).

The energy crisis is real and the days of cheap and plentiful
energy are gone, perhaps forever. Resources and technology are
available to meet the energy austerity. The good evolving from
the energy crisis means conservation in many considerations of
city planning such as master planning for transportation, water
supply, sewers, and utilities; urban construction; and recreation
facilities near subdivisions. Urban and suburban areas are evol-
ving from low density residential communities clustering around a
well-defined central city to a collection of regional subcenters
around the central-city area, each consisting of malls, high-rise
office buildings, industrial areas, and apartment complexes linked
by belt highways. (MCW)

MINERAL RESOURCES, ECONOMIC GROWTH, AND WORLD
POPULATION.

D.B. Brooks and P.W. Andrews.
Science, v.185, no.4145, July 5, 1974, p.13-19.

We are running out, not of mineral resources,
but of ways to avoid ill effects of high rates of
exploitation.

1974

1973

U.S. ENERGY RESOURCES: LIMITS AND FUTURE OUTLOOK.
E.S. Cheney.

Amer. Scientist, v.62, no.1, Jan-Feb.1974,
p.14-22.

The environmental, economic, political, and military dangers inherent in each of the major energy resources could be decreased by zero per capita power growth.

RESOURCE TRICHOTOMY. Distinguished Lecture-ship in Materials and Society. Boyd, J. (National Commission on Materials Policy, Washington, DC). Met. Trans.: 5: 5-10 (Jan 1974).

Although resources are available to meet man's needs, it requires the combined efforts of material scientists and governmental and financial institutions to make them available in the proper form and at acceptable costs. To accomplish all of this, while still enhancing man's surroundings, is also dependent on the ingenuity of the materials community, guided by government in its rule-making capacity. The problems involved in the development, production, and use of energy and materials are closely interwoven with each other and the protection of the environment. No policies guiding these activities can be successful unless all three are treated in concertance. Mankind cannot afford a trichotomy in the modern sense of cleavage. He must have it in its ancient meaning of trinity. (auth)

THE GAS SHORTAGE - HOW REAL IS IT.

U.S. News & World Rept., June 25, 1973, p.34,35.

Hundreds of gas stations are closing, fuel is hoarded, motorists are complaining. With problems come charges and countercharges. Americans everywhere want to know who's to blame.

FUEL SHORTAGES IN AMERICA: THE ENERGY CRISIS COMES HOME. J.H. Douglas.
Science News, v.103, May 19, 1973, p.342,343.

This is the first article in a series on the energy crisis. In the series, Science and Society Editor John H. Douglas will explore the extent and the causes of the crisis, new technological advances that promise relief, and the conflict of environmental concerns with the seemingly insatiable energy requirements of an industrialized society.

N74-16664# Committee on Interior and Insular Affairs (U. S. Senate).

FUEL SHORTAGES, PART 1

Washington GPO 1973 530 p refs Hearings before Comm. on Interior and Insular Affairs, 93d Congr., 1st Sess., 1 Feb. 1973 2 Vol.

Avail: Comm. on Interior and Insular Affairs

A Congressional hearing was conducted to investigate the factors contributing to current shortages of natural gas, residual oil, and other refined products. Testimony from the Senators of various states is submitted to show the extent of the energy crisis and their understanding of the basic causes. Communications from various segments of the economy are included to define the scope of the shortages and the impact on industry, public utilities, and home use. Tables of data are developed to show the resources available and the anticipated problem areas. The actions to be taken by Federal organizations to improve the energy situation are recommended. P.N.F.

N74-16665# Committee on Interior and Insular Affairs (U. S. Senate).

FUEL SHORTAGES, PART 2

Washington GPO 1973 270 p refs Hearings before Comm. on Interior and Insular Affairs, 93d Congr., 1st Sess., 22 Feb. 1973 2 Vol.

Avail: Comm. on Interior and Insular Affairs, 93d Congr., 1st Sess., 22 Feb. 1973

For Abstract See N74-16664

U.S. Federal Power Commission. Task Force on Fuels Availability.
TASK FORCE REPORT ON FUELS AVAILABILITY TO TECHNICAL ADVISORY
COMMITTEE ON FUELS, FEDERAL POWER COMMISSION, NATIONAL POWER
SURVEY. Washington, Federal Power Commission, 1973. 1 v.
(various pages)

U.S. Federal Power Commission. Technical Advisory Committee on
Power Supply. Task Force on Forecast Review. FORECASTS OF
ELECTRIC ENERGY AND DEMAND TO THE YEAR 2000. A Report by the
Task Force on Forecast Review to the Technical Advisory
Committee on Power Supply, National Power Survey. Washington,
Federal Power Commission, 1973. 1 v. (various pages)

N74-21824# Joint Economic Committee (U. S. Congress).
THE GASOLINE AND FUEL OIL SHORTAGE From the
Subcommittee on Consumer Economics
Washington GPO 1973 295 p refs Hearings before Joint
Econ. Comm., 93d Congr., 1st Sess., 1-2 May and 2 Jun.
1973
(GPO:99-740) Avail: SOD HC \$2.00

A Congressional hearing on the gasoline and fuel oil shortage
is presented. The impact of the shortages on the overall economy
of the nation is analyzed. The outlook for the fuel situation in
the period 1972 through 1975 is examined. Methods for correcting
the fuel shortage are proposed. The government policy with respect
to resources management and fuel allocations is discussed. The
economic condition and operating problems of various gasoline
and oil companies are reported by selected representatives from
these companies. P.N.F.

THE ENERGY CRISIS AND THE CHEMICAL INDUSTRY.

W.D. Tamm W.D. Trammell.
Chem. Eng., Apr.30,1973, v.80, no.10, p.68-86.

Elasticity of demand for gasoline in the south coast
air basin California Inst. of Tech., Pasadena, 1973
Environmental Quality Lab. SCHREIBER, I. R. 1973
18 PAGES REF. EOL-HEMO-10 Avail: Issuing

*CALIFORNIA, *DEMAND (ECONOMICS), *ECONOMIC ANALYSIS,
*GASOLINE
COSTS, STATISTICAL ANALYSIS, STOCHASTIC PROCESSES,
SUPPLYING, TIME SERIES ANALYSIS C34 B74-22561

N74-19618# Committee on Interior and Insular Affairs (U. S.
Senate).
THE GASOLINE SHORTAGE: A NATIONAL PERSPEC-
TIVE
David M. Lindahl Washington GPO 1973 98 p refs Presented
to Comm. on Interior and Insular Affairs, 93d Congr., 1st Sess.,
19 Jun. 1973 Prepared by Library of Congr.
Avail: Comm. on Interior and Insular Affairs
An overview is presented of factors contributing to the gasoline
shortage, the extent of the shortage, and its impact on the
country. Emphasis is placed upon problems of supply and demand
and remedial actions taken to alleviate the problem. Author

N74-20621# RAND Corp. Santa Monica, Calif.
ENERGY ALTERNATIVES FOR CALIFORNIA: THE CUR-
RENT CRISIS. 1: THE IMPACT OF ARAB OIL EXPORT
POLICIES ON THE CALIFORNIA ENERGY SYSTEM
William R. Ahern Dec. 1973 22 p refs
(P-5146) Avail: NTIS HC \$4.25

The objectives of this presentation are: (1) to indicate the
impacts of the Arab embargo of oil shipments to the United
States on the California energy system; (2) to show how these
impacts interrelate with the major trends in state energy supplies
and uses; and (3) to identify and measure the important energy
shortage allocation problems facing Federal and State officials.
Author

Energy alternatives for California: The current
crisis. 3: Allocation of scarce supplies RAND
Corp., Santa Monica, Calif. Ball, B. B. DEC.
1973 21 PAGES REFS. P-5157 Avail:-

*CALIFORNIA, *ENERGY POLICY, *FUEL CONSUMPTION, *RESOURCES
ALLOCATION
CRUDE OIL, DEMAND (ECONOMICS), ELECTRICITY,
GOVERNMENT/INDUSTRY RELATIONS, GRAPHS (CHARTS), NATURAL GAS
C34 B74-22596 *

The Role of Water in the Energy Crisis.
Nebraska Univ., Lincoln. Water Resources Research Inst.
1973. 221 W74-07961. OWR-A-999-NEB(13)
PB-232 404/4WE PCS5.75/MF\$1.45

Ways that the water resources community could help solve national and regional energy problems are presented. Topics discussed include energy-water relationship (economic, environmental, political-social, and technological), the role of water resources in the energy crisis, regional energy problems, and an assessment of research needs.

N74-18730# Electricity Commission of New South Wales, Sydney (Australia).
ELECTRICITY: THE CONVERSION INDUSTRY

N. B. Heel 1973. 10 p refs
(NP-19837) Avail: AEC Depository Libraries HC \$3.00
Planning of future electric power supplies is considered with specific reference to Australia. Topics covered include fuel reserves, fuel costs, electricity supply today, planning future supplies, energy transport, and the effect of changes on the consumer. Coal, uranium, and possibly natural gas coal reserves are clearly adequate to provide a supply of fuel at reasonable costs for power generation for well into the next century. In comparison with uranium and coal, known reserves of crude oil and natural gas in Australia are relatively small. NSA

(UCRL-51487) U. S. ENERGY FLOW CHARTS FOR 1950, 1960, 1970, 1980, 1985, AND 1990. Austin, A. L.; Winter, S. D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 16 Nov 1973. Contract W-7405-Eng-48. 18p. Dep. NTIS \$4.00.

Energy flow charts for the U. S., showing the origin and disposition of energy for the years 1950, 1960, 1970, 1980, 1985, and 1990, are presented along with a discussion of their development and the implications of the data they represent. An appendix describes the construction of one chart in detail, serving as an example of the method. (auth)

(WASH-1281-1) RESOURCE ASSESSMENT. Subpanel Report I Used in Preparing the AEC Chairman's Report to the President. McCulloh, T. H. (USAEC, Washington, D. C.). 13 Nov 1973. 147p. Dep. NTIS \$10.50.

The United States will be primarily dependent for its energy needs upon oil and gas, coal, uranium and hydropower well into the next century. Domestic sources of these supplies will be taxed to the utmost during the 1973-85 period. Options involving different energy mixes, different levels of energy production, and varying environmental and socio-economic impacts may be permitted in the long term by technological progress. However, the necessary decisions regarding such options cannot now be made intelligently without a much better understanding of the domestic energy fuel resource base. Resolution of the energy crisis, which is basically a domestic fuel shortage, will depend primarily on increasing conventional fuel supplies. More effective means for the discovery, evaluation, and development of these supplies are needed. Since the cited fuels and hydropower will remain the prime domestic energy sources for many decades, it is essential to recognize that each is characterized by unique features of availability, usability, and environmental acceptability. They are only partly interchangeable as fuels and more complete interchangeability will require the restructuring of many industrial processes. (auth)

IS AN ENERGY CRISIS INEVITABLE? Cook, D. C. Pub. Util. Forum. 92: No. 4, 17-22 (6 Aug 1973).

An electric energy crisis will probably result if the federal government does not modify deadlines for compliance with secondary air quality standards, but it will be short-lived. The energy outlook and the forms of energy available are discussed. The promise of nuclear power plants is shown to be far from bright, while the use of our large coal resources is hampered by the air quality standards. The need for a national energy policy and for common sense in recommending the standards with the need for electric power is pointed out. There is no reliable, commercially available technology for SO₂ removal from stack gases. (DLC)

N74-12690# Committee on Science and Astronautics (U. S. House).
SHORT TERM ENERGY SHORTAGES

Washington GPO 1973 927 p refs Hearings before Comm. on Sci. and Astronaut., 93d Cong., 1st Sess., No. 7, 3, 8, and 17 May 1973

Avail: Subcomm. on Energy
The hearings are reported concerning the causes and implications of the impending shortages of gasoline, heating oil, fuel oil, jet fuel, and electricity. Short term fuel shortages and their effects on electric utilities are analyzed. Other topics discussed include: natural gas supply, electric energy supply; R and D considerations, and convertibility of oil-fired electric utility plants to coal. F.O.S.

1973

N74-18679# Commission of the European Communities, Brussels (Belgium).
THE ENERGY SITUATION IN THE COMMUNITY. SITUATION 1972. FONECASTS 1973
9 Feb. 1973. 55 p
Avail: NTS HC \$4.75

An analysis of the world energy situation in 1972 and the outlook for 1973 are presented. The development of an energy policy which would improve the quality of information available concerning energy requirements and problems is discussed. The market situation in 1972 and its consequences are examined for the specific cases of petroleum, coal, gas, electricity, and nuclear energy. Tables, charts, and graphs are included to show consumption rates and predicted consumption of the significant natural resources used for energy conversion. Author

OVERVIEW OF SUPPLY/DEMAND FOR THE NEXT DECADE. Searl, M. F.; Schurr, S. H. (Resources for the Future, Inc., Washington, DC). Chem. Eng. Progr.: 69: No. 6, 27-34(Jun 1973).

The ability to bring the major new technologies into being quickly enough to make large additions to domestic supply for the period to 1985 is doubtful. It is believed, however, that the U. S. does have the option of increasing domestic production of oil and gas from expanded reserves during this time to help relieve the crisis. Commercially significant production from hydrocarbons, from advanced coal gasification techniques, and from shale oil and perhaps coal liquefaction appears possible in the 1985-2000 period. Domestic supply should increase from 1973. Technique development should allow the usage of high- and medium-sulfur coal in power plants. Light water reactors and high-temperature gas-cooled reactors may be strong competitors for the power plant market in the 1985-2000 period. It is suggested that federal energy R&D budget be devoted directly or through industry to work on oil and gas exploration, development, and recovery. (MCW)

ENERGY OPTIONS FOR THE UNITED STATES. Felt, F. IEEE (Inst. Elec. Electron. Eng.). Spectrum; 10: No. 9, 63-68 (Sep 1973).

The production, transportation, and utilization of energy has come to be associated with undesirable consequences such as pollution, degradation of the environment, and balance-of-trade deficit, and provisions for jobs, creature comforts, and a high standard of living have been forgotten. By sketching out an "anatomy of energy," the author hopes to steer public sentiment towards a more constructive perspective concerning the energy options available in the USA. The estimates and projections are checked with data from the Department of the Interior. The share of energy consumed and the exponential growth rate in the USA are discussed. Nuclear power and the new energy sources and systems are evaluated. Near-term energy needs may be helped by conservation and increased efficiency practices. The interrelationships of energy, geopolitics, international trade, economics, and national security are discussed. (MCW)

1973

TITLE: The Energy Outlook for Transportation in the United States
AUTHOR: Caspell, M. E.
PUBLICATION DESCRIPTION: Traffic Quarterly, 183-209, published by Eno Foundation for Transportation, Inc., Saugatuck, CT
PUBLICATION DATE: 1973, April
ABSTRACT: Since the future outlook for energy in transportation is the same as for energy in general, the author reviews the entire field. Included in the discussion are: U.S. consumption of energy resources; energy supply and demand; energy conversion and efficiency of conversion; depletion of energy resources; alternatives and prospects; energy costs; conservation of energy resources; power and fuel requirements for the automobile; and alternative automotive engines. The author feels that electricity is the only viable solution for automobiles. He urges "a continuing, comprehensive, coordinated, cooperative program of research and development in all aspects of energy production, transmission, and use". (MPC)

ENERGY OUTLOOK FOR THE 1980's. A Study Prepared for the Use of the Subcommittee on Economic Progress of the Joint Economic Committee, Ninety-Third Congress, First Session, by W. N. Peach, December 17, 1973. Washington, DC: Joint Committee on Atomic Energy (1973). 43p. GPO.
The prospects for developing energy resources in the United States are examined in the overview providing policymakers and the public much needed perspectives on the long-term energy outlook. The resources that can contribute to such expansion include coal; offshore production of oil and gas; Alaskan oil and gas; oil shale deposits; nuclear energy; geothermal energy; and Canadian tar sands. Possible improvements discussed include improved transportation, more intensive extraction of oil, and better conservation. (MCW)

WORLD DYNAMICS CHALLENGED: ENERGY RESOURCES.
A.J. Surrey and A.J. Bromley.
Futures, v.5, no.1, Feb.1973, p.90-107.

47
In recognition of the central importance of energy this chapter examines estimates of world energy reserves in the context of continued exponential growth in consumption. It is concerned with the question of whether there will be a world fuel crisis in the foreseeable future, and if so, what its nature is likely to be.

TITLE: World Energy Strategies: Facts, Issues, and Options

1973

1973

AUTHOR: Lovins, A.B.
CORPORATE AUTHOR: Earth Resources Research Ltd.
ADDRESS: c/o Friends of the Earth Ltd., 9 Poland St., London W1P 3JG, England
PUBLICATION DESCRIPTION: 55 p. monograph, 1st notes, introduction by Professor Dennis Gabor
CBE PMS
PUBLICATION DATE: 1973, November 15

ABSTRACT: This paper surveys 'or decision-makers the substance, rationale, and implications of a body of opinion on which many sophisticated energy strategists have recently begun to converge: doctrine inconsistent with the policies of most governments, but nonetheless coherent, and rapidly spreading. After a review of the conditions and prospects of man's very large and unevenly distributed energy conversion, the outlook for both conventional and unconventional fossil fuels is surveyed. Possible rates and side-effects of production, institutional problems, and the general trend towards fuels of increasing technical simplicity are assessed. Coal emerges in a critical role as the main bridge to sustainable energy economies. The commonly proposed successor to fossil fuels--nuclear fission--is then analyzed in detail, with specific reviews of several reactor programmes. The status, prospects, and possible problems of other energy technologies (nuclear fusion, geothermal power, tidal power, hydroelectricity, indirect and direct solar collection, etc) are then assessed and promising avenues identified: 1) revise energy conversion, storage, and distribution technologies. The foregoing considerations are combined with an assessment of certain ethical issues related to distribution, competition, climatic constraints, and future risks (e.g. in strategic-material safeguards, long transport, Arctic oil-spills, and radiation biology) to yield general conclusions about strategic options and how we should choose amongst them. (auth, Abstract Modified)
AVAILABILITY: Earth Resources Research Ltd., c/o FOR Ltd., 9 Poland St., London W1P 3JG England; (\$1.00 postpaid in US; \$5 postpaid via airmail in USA; \$9.50 postpaid in Europe.)

INTRODUCTION TO THE ENERGY RESOURCES OF CALIFORNIA. Ritzius, D. E.; Rothenmel, R. V. Sacramento, CA; California Division of Oil and Gas (1973). 66p.
Energy resources in California are discussed. Chapters are included on oil and gas origin and accumulation; oil and gas exploration methods; drilling methods; well completion and production methods; oil reservoirs; production stimulation methods; California's offshore fields; conservation; transportation of oil and gas; refining; history of production in California; environmental protection and enhancement; and geothermal resources. (NCW)

TITLE: Materials Requirements in The United States and Abroad in The Year 2000

AUTHOR: Mahabunan, W.; Cichowski, C.I.
AUTHOR: Mirzabagheri, P.; Riordan, J.
CORPORATE AUTHOR: University of Pennsylvania, Wharton School of Finance and Commerce
ADDRESS: Philadelphia, PA
PUBLICATION DESCRIPTION: Report No. PB-219/475, 40 p.

PUBLICATION DATE: 1973, March
SPONSOR: National Commission on Materials Policy
ABSTRACT: The main body of this report provides estimates of materials required in the year 2000 by nations other than the United States. It finds that each of the materials studied will be required by foreign lands in volumes at least three times as large as foreign lands required in 1966-69 (more than five times in the case of aluminum and fluorospar). Their share of total world requirements will expand by about 10%; the share of the United States will be correspondingly smaller. The annex to this report presents comparable estimates for the United States. For all materials, U.S. requirements are expected to exceed domestic production in 2000. Expanded requirements abroad and such import needs by the United States can only be met through growth in production in the rest of the world. However, as indicated in a note to the report, production abroad could meet both sets of requirements if it expanded during the next three decades at about half the annual rate of actual expansion during 1950-70. (auth, free introduction)
AVAILABILITY: NTIS

Energy: resources and demand in this century and beyond
Ray, G. F., Long Range Planning, 6, (1), 56-62, (Mar. 1973). This article constitutes a scenario of the supply and demand for energy over the next 30 years. Reference is made to speculation on future demand, energy resources, implications of rising costs, and nuclear energy.

N74-19629# Stanford Research Inst. Menlo Park, Calif.
1975-2000
MEETING CALIFORNIA'S ENERGY REQUIREMENTS.

May 1973 412 p. refs. Sponsored by Los Angeles Dept. of Water and Power, Pacific Gas and Elec. Co., Sacramento Municipal Utility District, San Diego Gas and Elec. Co., and Southern Calif. Edison Co.
ISBN Proj. ECC-23551
Avail: NTIS HC \$23.75

A study was conducted to determine various aspects of the present and future energy requirements for the State of California. The specific objectives of the study are as follows: (1) to assess the economic framework and related demand for energy, (2) to determine means for altering the projected demand pattern, requirements for implementing each of these demands, and appraisal of their significance, (3) to analyze the future supply from each source of energy and the factors affecting availability and use, and (4) to predict probable future trends in price.

1973

1973

FUEL CRISIS: AN ENERGY PEARL HARBOR.
Wakelield, S. A. Pub. Util. Forum.; 92: No. 12, 29-33/6 Dec 1973.

In relation to energy matters the time has come to decide what is essential and what is merely desirable, what can be afforded, and what must be done and what can wait. The author feels that the idea the Nation's present energy problems will somehow be solved and that normal conditions will return to the world oil market in the relatively near future is pure fantasy. In addition to Arab curtailments and the embargo, prices have been advanced. The embargo was an add-on to an already existing crisis produced by a deteriorating domestic oil and gas supply and failure to prepare for long-term energy needs to be met by large-scale development and exploration of oil, gas, coal, oil shale, and nuclear fissionable materials. This need must be met even if normal trade relations resume with the Arab nations. The alternatives are to mine and burn coal; explore and drill for oil and gas, onshore and offshore; build and license nuclear plants; and do all this and more within tolerable environmental restraints emphasizing human environment. (MCM)

SOME VIEWS OF THE ENERGY CRISIS.

A.M. Winberg. p.59-60.

ENERGY: PLANNING FOR THE FUTURE.

C.S. Cook. p.61-65.

Amer. Scientist, v.61, no.1, Jan./Feb.1973.

US ENERGY CRISIS: A SCIENTIST'S VIEW. White.

D. C. (Massachusetts Inst. of Tech., Cambridge). Energy Policy; 1: No. 2, 130-135(Sep 1973).

Energy consumption in the U. S. has increased 13-fold during the last 100 years. The increase resulted from growth in domestic consumption and private transport, goods requiring more and more energy in production and distribution, and essential energy-dependent services. The author argues that the crisis is a political and economic one and that growing energy consumption, dwindling domestic reserves, and environmental disruptions are merely symptoms. Resolving the problems of energy production and consumption issues requires that short-term remedies be undertaken, but in addition, long-term and fundamental investigations are necessary to develop alternative options for society many decades into the future. (MCM)

US, NOT ENERGY SHORT, STUDY SAYS.

Technology Forecasts, Oct.1973, p.12-14.

Canadian government study refutes the idea that the US is on the brink of running out of energy resources.

IS THERE AN ENERGY CRISIS? MANY VIEWS.

MANY ROUTES TO GAS.

POLITICS AND OIL.

FOR THE FUTURE: NUCLEAR POWER.

ONWARD FOREVER?

Tech. Rev., Feb.1973, p.57-59.

THE ENERGY CRISIS: ON AND ON AND ON...

J.J. McKetta, Univ. Texas.

Chem. Eng. Prog., v.69, no.8, Aug.1973, p.51-56.

Predictions made in the past two or three years for 1985's energy outlook not holding up; energy problem seen as more severe than ever.

45

1973

CH-129, 601, Nos. 593 & 594 (1973)
MEN AND MOLECULES. SIDE I: APPROPRIATE TO THE ENERGY
CRISIS. George Long. (Radio Series 594). SIDE II:
CHEMICALS IN THE ENVIRONMENT. Samuel Epstein.
(Radio Series 593). (1973). (Audiotape).

American Chemical Society
American Chemical Society
American Chemical Society
Radio Series 594
Radio Series 593

Power sources
Energy

(Ordered for E.E. Mason 5-73-
~~no order number~~). 476/25
L-5-28-73

CH-129, 959, (Lectures) 122 (1973)
ENERGY: A DIALOGUE. Norman Metzger, ed. (LECTURE 1):
THE ENERGY CRISIS: MYTHS AND REALITIES. (Sidney
Siegel, ORNL, et al). (LECTURE 2): WHAT LIGHTS THE
LIGHTS. (John O'Leary, AEC, et al). (1973).
(Audiotape).

American Association for the Advancement
of Science
Oak Ridge National Lab.
Atomic Energy Commission

Audiotapes - Power sources
Power sources
Energy conservation
Environment
197, 223
L-9-21-73

ENERGY CRISIS AND CHALLENGE. G.D. Friedlander.
IEEE Spectrum, v.10, no.5, May 1973, p.18-27.

After a century of feasting, the US now finds
itself facing a fuel famine, with no immediate end
in sight.

ENERGY: LIFEBLOOD OF OUR CITIES.
J. Grey.
Astronautics & Aeronautics, v.11, no.12, Dec.1973
p.52-54.

Environmentalists and producers at third
Urban Technology conference energy session
split over how to meet the shortage - cut demand
or increase supply.

ENERGY CRISES IN PERSPECTIVE. Fisher, J.C.
(General Electric Co., New York). Phys. Today, 26: No. 12, 40-
44; 49; 51 (Dec 1973).
Estimates of US energy resources and projections of future en-
ergy consumption show that the country has enough fossil fuel to
last 500 years and enough nuclear fuel to last for a million years.
If nuclear fuels or other fuels take part of the energy demand,
fossil fuels will last longer. The present energy crisis was caused
by many factors. The unanticipated environmental movement pre-
cipitated a crisis in the US because more petroleum products and
more refinery capacity were needed as consumers shifted to oil
from coal and from planned uranium. Natural-gas price regulation
was a factor. The uncertain viability of high-cost US crude oil and
refined products in the face of a potential flood of low-cost im-
ported crude oil and refined products inhibited US petroleum de-
velopment and refinery construction. The projected energy con-
sumption, with data on energy sources and reserves, is discussed.
In the long-term, progress in technologies and the advent of syn-
thetic oil from coal or shale is expected. (MCW)

THE ENERGY GAP.
G. Foley
Atmospheric Environment, v.7, 1973, p.1229-1235.

Energy consumption is predicted to increase in the
U.K. and much physical planning assumes this.
This paper argues that most of the assumptions
are invalid; forecasts of energy supply are compared
with those of demand, showing that shortage of energy
will prevent realization of the plans.

1973
CE-129,741
ENERGY CRISIS IN AMERICA. 1973. 93p.

Congressional Quarterly, Inc.

Power sources
Energy consumption
Earth - resources

CE-129,768 1973
ENERGY: HOW CRITICAL IS THE CRISIS?

Consulting Engineer, (U.S.) March 1973

Power sources
Power plants
Earth - Resources
Gases, Natural
Energy conservation

L-7-26-73

ENERGY: A TANTALIZING SUBJECT. A.J. Meyer.

EXXON USA, First quarter 1973, p.9,10.

Using conservative estimates, energy demand will more than double by 1985, and certainly will quadruple by the end of this century.

1973

N74-14691# Select Committee on Small Business (U. S. House).
ENERGY CRISIS AND SMALL BUSINESS
GPO: Washington 1973 65 p refs Presented to Select Comm. on Small Business, 93d Congr., 1st Sess., 13 Jul. 1973
Avail: Select Comm. on Small Business
Results are presented of an investigation of the petroleum industry made by the Federal Trade Commission. The investigation looks into the growing shortage of gasoline and its effects on small businesses, especially the independent gas station operator. The origins and nature of the present gasoline shortage can only be understood with reference to the structure, conduct and performance of the entire industry. The focus of the discussion includes: background and methodology of the current petroleum investigation; structure, conduct, and performance of the petroleum industry; and Committee staff conclusions. AL

CE-129,601. Nos. 578 & 577 (1973)
MEN AND MOLECULES. SIDE I: ENERGY A CRITIQUE.
Dean Abramson. (Radio Series 578). SIDE II:
PUZZLES OF AIR POLLUTION. Arthur Levy. (Radio Series 577). (1973). (Audiotape).

American Chemical Society Radio Series 578
American Chemical Society Radio Series 577
American Chemical Society

Audiotapes - Energy Crisis

Power sources 193,264

Audiotapes - Air pollution
Air pollution

SPECIAL REPORT ON ENERGY:

DDC to boost domestic petroleum share.
Senate votes to boost OAP powers.
Prospects dim for North Atlantic energy cuts.
Fuel allocation spurs 5% fare increases.
General aviation braces for fuel cuts.
Aviation: No Space Tech., Nov. 26, 1973, p20-23.

45

1973

N74-12672# Committee on Science and Astronautics (U. S. House).

ENERGY FACTS

Washington: GPO, Nov. 1973. 458 p. refs. Presented to Comm. on Sci. and Astronaut., 93d Congr., 1st Sess., 29 Nov. 1973. Prepared by Library of Congr. Avail: Subcomm. on Energy

A congressional report on United States and foreign energy statistics is presented. Tables on the most common and some unconventional energy sources are developed. The statistical tables and graphs are grouped by resources, production, consumption and demand, energy and gross national products, and research and development. An inventory of world wide nonrenewable energy sources in the forms of natural gas, natural gas liquids, crude oil, shale oil, and coal is developed. Author

CERTAIN BACKGROUND INFORMATION FOR CONSIDERATION WHEN EVALUATING THE NATIONAL ENERGY BILL. Prepared at the Request of Melvin Price, Chairman, Joint Committee on Atomic Energy by Staff of JCAE, Ninety Third Congress, First Session. Washington, DC: Joint Committee on Atomic Energy (1973). 37p. GPO \$1.85.

A graphic presentation was prepared by the staff of the Joint Committee on Atomic Energy to obtain a reasonable understanding of the broad problems, scale, and complexity of the energy dilemma. A method was devised for visually displaying projected future effects of various energy policies on the domestic energy situation. (JCV)

HOW MUCH IN RESERVE. Whittemore, F. C. (Unit, of Virginia, Charlottesville). Environment, 16: No. 7, 16-20; 21-36 (Sep 1973).

Methods of estimating the major fuel resources of coal, oil, gas, and uranium are compared. The goal of this comparison is to recommend change in current-estimation methods for a nation struggling with energy problems. The method for each fuel has strengths and weaknesses. The best features of the different estimates are combined to form the ideal model that includes annual updating, standard definitions, estimation of resources, physical parameters, geographical breakdown, new universal terminology, full disclosure of known data, and productive capacity. It is shown

that the characteristics should be treated as a basis for future consideration and will treat the resource estimation as a whole rather than on a fuel-by-fuel basis. (ATCW)

1973

N74-16690# Massachusetts Inst. of Tech., Cambridge. Energy Lab.

MODELING OF ELECTRIC POWER DEMAND GROWTH

Final Report

J. B. Woodard, Jr., M. L. Baughman, and F. C. Schweeppe. Feb. 1973. 20 p. refs. Presented at MIT Conf. on Energy Demand, Conservation and Institutional Probl., 12-15 Feb. 1973. (Grant NSF GI-32874)

(PB-224045/5GA: MIT-EL-73-015) Avail: NTIS HC \$3.00 CSCL 108

The paper describes a modeling approach, presently under development, directed at the growth in demand for electric power. The emphasis is to develop a mathematical model which can be used for the analysis of detailed questions, such as: How will changes in air conditioning power demand, electric rate structures, population, etc., affect the daily load shapes (MW vs time) as well as the peak power and the overall electric energy consumption. Detailed answers to these questions are needed for generation planning of capacity and plant mix (nuclear, fossil, and pumped-hydro) as well as for the evaluation of the resulting environmental and economic impacts. These issues require detailed models combining economic models with engineering considerations affecting the dynamics of load behavior. Modeling of this kind can be limited by the data available, and an important aspect of this effort is to identify the data required for a detailed understanding of the load. The approach to be employed is a combination of state dynamic models driven by stochastic processes with economic models. GRA

1973

(ORNL-NSF-EP-50#) PROJECTIONS OF ELECTRICITY DEMAND. Tyrrell, T. J. (Oak Ridge National Lab., Tenn. (USA)). Nov 1973. Contract W-7405-eng-26. 25p. Dep. NTIS \$3.25.

With the arrival of the "Energy Crisis" the need for accurate predictions of electricity demand becomes crucial. For decades reasonably accurate results have been obtained by simple extrapolation of historical growth rates. Recently, however, changes have occurred in some of the underlying economic factors, increasing the desirability of a more sophisticated predictive approach. Recently developed econometric models describe electricity demand as a function of population, per capita income, and prices of electricity, gas, and electrical appliances. Some features of one such model illustrate the projections that can be made using it. These projections are found to be generally lower than other well-known forecasts, and, depending on assumptions, show a wide range of possible future electricity demand levels. (auth)

1973

ENERGY FOR THE FUTURE. Report of the Working Party on Energy Resources and Policy. London: Institute of Fuel (1973). 36p.

It is concluded that the availability of reasonably priced oil to meet the projected increased demand over the next 20 years is in doubt. It is recommended that part of this demand should be reallocated to indigenous fossil fuels (particularly coal) and nuclear fuel, leaving oil to supply those markets where no alternative fuel is possible. Detailed proposals are made, including recommendations for the development of nuclear power (a full-scale breeder-reactor-based station to be built as soon as practicable), a foolproof nuclear waste disposal system to be developed as a matter of extreme urgency, and research into fusion power to be substantially increased. The report is in sections: future patterns of fuel usage, fuel reserves, fuel and politics, fuel and the environment, UK reserves and patterns of fuel usage, EEC fuel provision, future development of energy sources (coal, oil, gas, hydroelectricity, and nuclear power), energy policy and the UK. (UK)

(ORNL-NSE-EP-49) ELECTRICITY DEMAND IN THE UNITED STATES: AN ECONOMETRIC ANALYSIS. Mount, T. D.; Chapman, L. D.; Tyrrell, T. J. (Oak Ridge National Lab., Tenn.). Jan 1973. Contract W-7405-eng-26. 28p. (CONF-730206-6). Dep. NTIS \$3.50.

From conference on energy, demand, conservation, and institutional problems; Cambridge, Massachusetts, USA (13 Feb 1973). The growth of demand for electricity since 1948 is attributed to five factors: population, income, and the prices of electricity, substitute fuels (natural gas), and complementary products such as household appliances. The data are annual observations for 48 contiguous states from 1946 to 1970. Single-equation models are fitted for three consumer classes (residential, commercial, and industrial) with the quantity of electricity as the dependent variable. Both constant and variable elasticity models are estimated. In all cases, a lagged dependent variable is used as a regressor, implying that demand adjusts through time to changes of the explanatory variables (geometric lag distribution). With a lagged dependent variable present, ordinary least-squares (OLS) estimators are inconsistent if the residuals are serially correlated. For this reason, a consistent instrumental variable (IV) estimator is used to check the OLS estimates. The estimated adjustment rates are higher with IV than with OLS. However, the long-run elasticities have similar magnitudes using both methods. (auth)

N74-22610# Interior Dept., Washington, D.C.
UNITED STATES ENERGY FACT SHEETS, 1971
Feb. 1973 144 p
Avail: NTIS HC \$10.25

Basic aspects of the nation's fuel-energy situation are outlined. Information for the individual states as well as regions is presented. Data from many different publications are consolidated with emphasis on basic facts and patterns about our fuel-energy picture from state and regional viewpoints. Energy Fact Sheet is a series of tables for the individual states. The tables summarizing the data for the various regions and the nation provide broad-scale comparisons. Several illustrations are included to portray some salient facts. The location of fuel reserves are shown on several maps.

Author

EN-140, 186 1973

DIALOG ON ENERGY SUPPLY AND DEMAND. (Includes: ENERGY-PRESSURE STATUS AND IMPLICATIONS. Marjorie P. Helms, U. of Arizona. SOLAR ENERGY - SOLUTION AND TECHNICAL CONSIDERATIONS. Adam B. Helms, U. of Arizona. ENERGY - A REORIENTATION IN DEMAND. Roger S. Carlsmith, ORNL-NSE Environmental Program). (Presented at Lehigh, Nov. 15, 1973). (Series title: Langley Colloquium Series). (1973). (Audiotapes - 2 sessions).

Arizona U.
Oak Ridge National Lab.
NASA
Langley Research Center

Power sources
Power sources, solar
lectures - Power sources
Audiotapes - Energy crisis

L-12-11-73

EN-140, 235 1973

THE NATION'S ENERGY FUTURE. A Report to Richard M. Nixon, President of the United States. Dixy Lee Ray, ABC. Dec. 1, 1973. 171p.

Atomic Energy Commission
Atomic Energy Commission
White House

Reports, Presidential
Research - Power sources
Research, Federal
Power sources
Energy consumption

WASH-1281

L-1-3-74

47

N74-71957 #

(AD-762586) PROJECTING CALIFORNIA'S ELECTRICAL ENERGY DEMAND. Moor, W. E. (Rand Corp., Santa Monica, Calif. (USA)). Jan 1973. 23p. NTIS \$3.25.

The methodology that was developed for the state of California for use in analyzing and estimating future electrical energy demands in the state is described. (GRA)

U. S. Energy Outlook: Fuels for Electricity, 1973. National Petroleum Council, 1625 K Street, N.W., Washington, D. C. 20006. 58 pp. paper. \$6.00.

This is one of a series of reports of the U. S. Energy Outlook Committee of the National Petroleum Council. The purpose of this study is to provide the committee with views on the electric utility industry's fuel requirements through 1985, the associated capital requirements for power plants and transmission facilities, and the relative capabilities to build and operate nuclear and fossil-fuel steam-electric plants. The report consists of the following sections: (1) primary energy requirements of the electric utility industry (1975-1985), (2) relative capabilities of the electric utility industry to build and operate nuclear and fossil-fuel steam-electric plants through 1985, (3) investment requirements through 1985, (4) environmental policy factors bearing on electric utility fuel and plant decisions, (5) fuel supply and utilization problems as viewed by the electricity task group, (6) regional summaries of electric utility fuel supply and problems, and (7) trends to the year 2000.

N74-14685 Oklahoma Univ., Norman.

MANERGY: AN ENERGY MANAGEMENT MODEL OF THE UNITED STATES FOR THE PREDICTION OF ENERGY DEMAND, RESOURCE CONSUMPTION, ENVIRONMENTAL EFFECTS, THE ASSESSMENT OF NEW TECHNOLOGY, AND ENERGY RESOURCE ALTERNATIVES Ph.D. Thesis William Woodrow Talley, II 1973 723 p

Avail: Univ. Microfilms Order No. 73-23321

A computerized, systems-analysis model of the United States energy system has been developed and presented in code form. The model was designed for use as a management tool for assessing the consequences of resources and fuel alternatives, environmental controls, and technological advances. The assessment guidelines are presented as resource consumption, environmental impacts, and balance of payment deficits to the year 2100. The model's capabilities and its inherent flexibility have been demonstrated for a baseline case and several alternatives. The base case was based on current energy use patterns, diversified resource development, projected fuel splits, population and gross national product projections, and reasonable advances in technology. The model has sufficient flexibility to include the results of the many existing and future studies on energy supply and demand. It quantifies the impacts of energy policy decisions into acceptable indices. As such, it has the capability to provide energy management guidelines necessary to make decisions on research and development priorities, legislation and regulations.

1973

ENERGY IN THE USA AFTER THE PRESIDENT'S MESSAGES: LIKELY EFFECTS ON SUPPLY AND DEMAND.

McDonald, S. L. (Univ. of Texas, Austin). Energy Policy, 1: No. 3, 179-186(Dec 1973).

When the President's proposals to deal with the energy crisis in the USA are classified according to the time that must elapse before they yield significant results, a logical pattern emerges. In the short run (less than three years) there is little that can be done to increase supplies of domestically produced oil and gas, the two most critical energy sources. So to avoid rationing or sharply rising prices it is necessary to yield some ground in respect to national security and environmental protection: to free oil imports of quantitative restrictions and delay further restraint of high-sulphur coal consumption so as to increase the supply of oil and decrease the demand for gas and fuel oil. In the intermediate run (three to six years) it is possible to do something about oil and gas supplies from domestic sources. They can be significantly increased in this period by accelerating the leasing of areas in the outer continental shelf, constructing the Alaskan pipeline, and granting tax credit incentives to exploration. At the same time the deficient supply of gas can be remedied by allowing the price to rise to the market-clearing level, and the demand for oil and gas can be reduced by conserving energy at the consumer level and speeding up the development of geothermal and nuclear power. It is possible that as a result of these measures the share of imports in total oil consumption will stabilize (although the construction of deepwater ports to handle super tankers will tend to make imports more competitive) and the reduction of high-sulfur coal consumption necessary to protect the environment can be afforded. In the long run (six years and more) an immediate increase in public spending on energy R & D and early implementation of a large-scale pilot program in shale oil development may be expected to yield additional supplies of oil from shale, additional supplies of gas from coal, and restrained demand for oil and gas as the result of new techniques in nuclear power (fast breeder reactor) and new means of protecting the environment from the effects of mining and burning high-sulfur coal. (auth)

1973

ENERGY DEVELOPMENT: PAST, PRESENT, AND FUTURE.

J.T. Ramey.

IEEE Trans. Nuc. Sci., v.NS-20, no.1, Feb.1973, p.43-47.

Discusses the three phases of the energy problem: short-term, intermediate-term and long-term energy problems.

1973

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1973

1973

(CONF-730223-1) ENERGY RESOURCES AND USAGE.
Charles Koelling Research Lab. Technical Note ER-2. George,
D. W. (Sydney Univ. (Australia). Dept. of Mechanical Engineer-
ing). Feb 1973. 23p. Dep. NTIS (U.S. Sales Only) \$3.25.
From maximum utilization of industrial energy conference,
Sydney, Australia (21 Feb 1973).
The overall picture shows that Australia faces no foreseeable
energy problems. Such an assumption ignores many technological
and environmental problems associated with the inefficient or
thoughtless use of invaluable energy resources. Energy wasted
is irrecoverable whereas energy un-used has a potentially in-
dividual and national good either in subsequent usage or in export
to some less-favorably placed country. No rushed or ill-considered
decision need be made, and with the advent of nuclear power or an
export decision to be made, the decisions may be well planned.
Issues such as Lake Pedder, the Clutha controversy, and the forth-
coming public inquiry into environmental aspects of the proposed
Moomba-Sydney natural gas pipeline give an indication of the
pattern of the future, and an informed public interest in such
matters should be welcomed by all concerned. National planning
and coordination are correlated with technological advances for
the optimum decisions to be made involving energy. (24 references)
(MCW)

N74-15214# Geological Survey, Washington, D.C.
UNITED STATES MINERAL RESOURCES
Donald A. Brobst, ed. and Warden P. Pratt, ed. 1973 722 p
refs
(USGS-PP-820: LC-73-600060) Avail: SOD HC \$9.15 Domestic
Postpaid or \$8.50 GPO Bookstore
Exploration and management of mineral sources are assessed
for the U.S. potential in comparison with worldwide deposits.
For individual titles, see N74-15215 through N74-15282.

THE SCRAMBLE FOR RESOURCES.
Business Week, June 30, 1973, p.56-63.
Special Report: Moving from an age of
resource abundance to resource scarcity.

N74-14866 Institute of Gas Technology, Chicago, Ill.
REVIEW OF WORLD ENERGY SUPPLIES
Henry R. Linden London Intern. Gas Union 1973 40 p refs
Presented at the 12th World Gas Conf., Nice, 1973
(IGU/A-1-73) Copyright. Avail: Issuing Activity
On the basis of currently definable technology and economics,
world energy resources are insufficient to support historical rates
of growth much beyond the middle of the 21st century. Further,
conventional energy supply systems appear to be inadequate to
support these growth rates under the expected limitations of
the use of investment capital, raw materials, and air, water and
land resources. New energy supply systems are discussed,
including those for conversion of the lower grades of fossil
fuels to nonpolluting fluid fuels and those employing hydrogen
as the energy form. The state of technological development of
the most promising fossil fuel conversion processes, and their
thermal efficiencies, operating characteristics, investment costs,
and prospects for industrial use are reviewed. Particular reference
is made to the major commercialization effort already underway
in the United States. The advantages of a hydrogen-based
economy over complete electrification are discussed in detail.
Although major emphasis is placed on the adequacy of fossil
fuel and uranium resources in meeting future requirements and
on delivery systems for these energy sources which are compatible
with investment cost and environmental limitations, the major
renewable energy resources are also reviewed briefly. Author

ENERGY OUTLOOK: NOW TO 1986. Kruger, P.
(Stanford Univ., CA). Awarre; No. 36, 3-7 (Sep 1973).
The United States has supported its population expansion, its
economic growth, and its high standard of living by means of an
accelerating utilization of low-cost energy. Fossil fuels are
finite and nonrenewable. The increasing awareness of the expo-
nential growth of energy consumption, the rapid depletion of
natural resources, the lagging development of new energy re-
sources and technologies, the strain on the dollar in world
markets, and the growing public and institutional demands for
energy and materials conservation and environmental protection
have forced the government to look for energy economy. Broad
studies of projected energy consumption and the possibilities for
conserving energy while enhancing the quality of the environment
were reported by the National Petroleum Council, 1971-1972.
The conclusions are summarized. Other studies by the U. S.
Atomic Energy Commission and Dupree and West are cited. The
Office of Emergency Preparedness (1972) suggested that energy-
conservation measures can reduce U. S. Energy demand by 1980
by as much as the equivalent of 7.3 million barrels of oil per day.
Aspects of all energy sources were investigated. (MCW)

43

1973

Environment, v.15, no.8, Oct.1973.

MORE RESISTANCE TO ELECTRICITY

18

Duane Chapman, Timothy Tyrrell, and Timothy Mount

Confident predictions of continued rapid growth in demand for electricity will prove false as prices rise, population growth slows. Massive new power plants now being built in the expectation that electricity usage will continue to double every ten years may turn out to be bad investments.

Chem. Engineering Progress, v.09, no.6, June 1973.

Technology and Future Needs: Introduction	21
An Energy Policy From the Federal Standpoint	22
An Overview of Supply/Demand for the Next Decade	27
Challenges in Production of Fossil Fuels	35
Challenges in Utilizing Fossil Fuels	40
Environmental Challenges and Nuclear Fuels	48
Discussion, Discussion	54

NO OVERDRAFTS IN THE ENERGY ECONOMY.

P. Chapman.

New Scientist, May 17, 1973, p.408-410.

Unless technology can find a way round the laws of thermodynamics, growth in material production must end within the next 100 years.

THE ENERGY CRISIS: REAL OR IMAGINARY?

R.C. Guinness.

Chemical Engineering Progress, v.68, no.4, Apr.1972, p.26-32.

THE ENERGY "JOYRIDE" IS OVER.

E. Fattermayer.

Fortune, Sept.1972, p.99-101, 178, 180, 182, 184, 186, 188, 191.

Technology and good sense can stretch our resources, but only a big breakthrough can bring back cheap fuel and power.

FUEL AND POWER IN THE 21st CENTURY. M.W. Thring.

Electronics & Power, Jan.1972, p.3-4.

We shall be extremely short of fuel by the year AD 2000 if the present rate of consumption continues. What resources remain, and how can the best use be made of them?

1972

**N74-16652 Gonzalez (Richard J.), Houston, Tex.
FUTURE UNITED STATES POPULATION, ECONOMIC
GROWTH, AND ENERGY DEMANDS**

Richard J. Gonzalez. /n Denver Univ. Balancing Supply and Demand for Energy in the US 1972 p 1-8 (For availability see N74-16651 07-34)

The impact of United States population and economic growth on energy demands is discussed. The need for reasonably rational analyses based on correct information and on realistic assumptions with respect to the future energy requirements is stressed. The subjects considered are: (1) the outlook for U.S. population, (2) the potential for U.S. economic growth, (3) probable U.S. energy requirements, and (4) perspective on long term energy problems. The author concludes that the future welfare of mankind requires that energy problems receive the best possible rational study as the basis for intelligent decisions about all policies and actions that affect energy availability, cost, and use. Author

GRAPHICAL VIEW OF ENERGY SUPPLY AND DEMAND, McKeith, John J., (Inst. of Texas, Austin), Chem. Eng. Progr. 68: No. 10, 24-26 Oct 1972

Data are presented graphically which show that the US cannot meet the energy demands between now and 2000 A.D. Recommendations are included on methods of meeting the energy crisis. (U.R.D.)

**N74-16689 Westinghouse Electric Corp. East Pittsburgh, Pa.
Fuels and Energy Systems.
THE EFFECT OF FUEL AVAILABILITY ON FUTURE R AND
D PROGRAMS IN POWER GENERATION**

L. G. Hauser, W. H. Combs, and R. R. Boyle Apr. 1972 20 p refs Presented at Am. Power Conf., Chicago, 18-20 Apr. 1972

Avail: NTIS HC \$3.00
An analysis of the energy requirements of various sectors of the U.S. economy is presented. Charts are developed to show trends in energy consumption and predictions of energy availability. The use of the load duration curve as a method for analyzing future electrical energy production is explained. Graphs are included to show the distribution of energy generated by capacity factor of the generating plants. Future research and development programs with emphasis on nuclear fuels and breeder reactors as a solution to the energy shortage are proposed. The creation and utilization of new methods for exploiting coal reserves are stressed. Author

**N74-16659 Kerr-McGee Corp., Oklahoma City.
BALANCING THE DEMAND AND SUPPLY OF ELECTRICITY
AND NUCLEAR FUELS**

Dean A. McGee. /n Denver Univ. Balancing Supply and Demand for Energy in the US 1972 p 115-130 refs (For availability see N74-16651 07-34)

The problem of obtaining a balance between demand and supply of nuclear fuel for electric power generation in the United States to 1985 is discussed. It is stated that the balance will depend on economic rather than geologic considerations. Proven reserves of uranium and the quality of the resource base that offers potential for new discoveries assure that uranium ore deposits available for development and production will be sufficient to meet demand. Projections are made in the growth of the nuclear powered electric energy field. The operation of the nuclear reactors and the nuclear fuel cycle involved in electric power production are described. Charts are included to show the projected utilization of nuclear fuels and the mix of coal, hydro, gas, thermal, and nuclear fuels to the year 2000. Author

**(NP-18772) WORLD ENERGY SUPPLY/DEMAND
DURING A PERIOD OF CRISIS. (Interdevelopment, Inc., Arlington, Va. (USA)). Dec 1972. 180p. Interdevelopment, Inc., Arlington, Va. (USA).**

In 1966 oil contributed 40%, coal 38%, gas 20%, and other sources (mainly hydroelectric) 2% to the total world-energy consumption of approximately 165,000-trillion Btu. Coal lost its lead in about 1960. The present world-energy situation will probably lead to significantly higher energy prices and pressure to reduce energy consumption. Coal represents the largest available potential source of energy from fossil fuels in the world, but the geographical distribution often does not match the location of areas of high consumption. Moreover, increasingly stringent air-pollution control regulations preclude the use of much of the coal with a high sulfur content until commercially economic processes to remove sulfur-dioxide from stack gases or to gasify coal become available. At current production rates proved world reserves of oil and gas would last some 30 to 40 years, and production is increasing rapidly. Although actual reserves are undoubtedly considerably greater, the locations will probably involve appreciably higher exploration and production costs than in the past. Oil shale and tar sands represent a significant potential source of oil. In spite of high conversion costs, these reserves will become commercially interesting as other supplies dwindle. Even without breeding, world uranium supplies seem adequate to supply demand without a large increase in price for many years. If present projections of installed nuclear capacity are correct, additional enrichment capability will be required in the early 1980's. The international trade in fuels, already quite large, will undoubtedly expand greatly in the coming years, and a significant increase in tanker capacity will be required. (auth)

1972

1972

1972

(BNL-17280) UNITED STATES ENERGY CRISIS:
SUPPLY AND DEMAND. Sallor, V. L. (Brookhaven National
Lab., Upton, N. Y.). Indl. 43p. (CONF-721042-1). Dep.
NTIS.

From Science Teachers Association annual meeting; Klamath,
NY. (23 Oct 1972).
Alternatives to the present pattern of energy production pro-
cesses are discussed. Discussions are included on US energy
balance, generation of electricity, environmental effects of
energy production and use, and air pollution. (J.R.D.)

(BNL-17282) GLOBAL ENERGY NEEDS. Sallor,
V. L. (Brookhaven National Lab., Upton, N. Y.). 14 Oct 1972.
13p. (CONF-7210-1). Dep. NTIS.
From International convocation: 1972 meeting; New York, NY
(14 Oct 1972).

The production and use of energy through the world are dis-
cussed. Relations between advancement in the various societies
and their energy consumption are noted. Data and discussions
are included on per capita energy use in selected countries, total
energy consumed in selected countries and by continent, and
energy exporters. (J.R.D.)

(BNWL-1699) ELECTRICAL LOAD FORECASTING.
A Review. Reardon, W. A. (Batelle Pacific Northwest Labs.,
Richland, Wash.). 3 Nov 1972. Contract AT(15-1)-1830. 74p.
Dep. NTIS \$5.75.

All capacity planning by electric utilities must begin with a
forecast of rates of electric energy. The perceived need then
forms the basis of system planning. The purpose of this study is
to examine the various methods of load forecasting used by elec-
tric utilities. A rather extensive survey of this sort was carried
out by a panel assembled by the Federal Power Commission
(The Methodology of Load Forecasting, 1969). This study, rather
than repeat all that work, was devoted to determining if the
methods had changed, determining what research is being carried
out on the area, and looking into the factors that a utility considers
when a capacity addition is to be made. These extensions carry
into such areas as system reliability, reserve margins, uncer-
tainties, etc. The economic factors of financial arrangements and
corporate strategy are beyond the scope of this study. (auth)

TRENDS IN ENERGY NEEDS.
F. A. Ritchings.
Mech. Eng., v.94, no.8, Aug.1971, p.18-23.

Energy requirements and availability of energy
supplies are subjects of increasing interest.
Here is a briefing on U.S. energy requirements
as related to total world requirements, on the
sources of energy consumed in the U.S., and pre-
dictions as to the rate of increase in U.S.
energy consumption.

(NP-19835) TELS FOR THE ELECTRIC UTILITY
INDUSTRY, 1971-1985. (National Economic Research Asso-
ciates, New York (USA)). 15 Aug 1972. 173p.

For Edison Electric Inst., New York.
An assessment, nationally and by regions, is made of the out-
look for electricity demand, and of the price and availability of
the fuels which will be required to generate that electricity in
1980 and 1985. Comparisons between fuel forms are made.
(DLC)

N74-18600 Institute of Energy Economics of Japan.
ENERGY DEMAND IN JAPAN, 1975 TO 1985
Masao Sakasaki /In Mitre Corp. Symp. on Energy, Resources
and the Environment. Vol. 3. 14 Apr. 1972. p 20-31 (for
availability see N74-18598 09-34)

The outlook on Japanese demand for energy and supplies
for meeting this demand until 1985 is discussed. Indigenous
sources of energy will meet only seven percent of the total
energy demand; this necessitates the development of electric
nuclear power plants in Japan and of uranium resources in
overseas countries. Disposal of radioactive wastes poses a serious
environmental problem.
G.G.

CH-129,577

1972

GUIDE TO NATIONAL PETROLEUM COUNCIL REPORT ON UNITED STATE ENERGY OUTLOOK. John G. McLean, Chairman, Committee on U.S. Energy Outlook. (Presentation made to the National Petroleum Council, Dec.11,1972). 1972. 40p.

National Petroleum Council

Energy

Power sources

CH-129,688

1972

U.S. ENERGY OUTLOOK. A REPORT OF THE NATIONAL PETROLEUM COUNCIL'S COMMITTEE ON U.S. ENERGY OUTLOOK. Dec.1972. 381p. (To be used in conjunction with CH-129,577).

National Petroleum Council

Power sources

Fuels - Availability

TITLE: U.S. Energy Outlook, A Summary Report of the National Petroleum Council

AUTHOR: McLean, J.G. (Chairman)

CORPORATE AUTHOR: National Petroleum Council, Committee on U.S. Energy Outlook

ADDRESS: 1625 K Street NW., Washington, DC 20006

PUBLICATION DESCRIPTION: 134 p.

PUBLICATION DATE: 1972, December

SPONSOR: U.S. Dept. of Interior

ABSTRACT: This report is the result of a request from the Department of the Interior to the end project the energy outlook as near to the end of the century as feasible, to evaluate trends, to indicate ranges of possible outcomes, and to emphasize where federal policies could contribute to obtaining an optimum energy situation. Included in the report are chapters on energy supply and demand balances, the availability of domestic and foreign oil and gas supplies, capital requirements for resource development, energy trends beyond 1985, and recommendations for a U.S. energy policy. The availability of other domestic energy sources, such as coal, nuclear, oil shale, and geothermal, is also considered. (HRC)

AVAILABILITY: National Petroleum Council (\$6.50)

CH-129,869

1972

CALIFORNIA'S ELECTRICITY QUANDARY: I. ESTIMATING FUTURE DEMAND. W.E. Moos and C.C. Now. (Prepared for the Resources Agency of Calif.). (See companion Rand Studies - R-1115-RP/CSA, "CALIFORNIA'S ELECTRICITY QUANDARY: II. PLANNING FOR POWER PLANT SITTING. By R.H. Ball, R.G. Salter, et al. R-1116-RSF/CSA, "CALIFORNIA'S ELECTRICITY QUANDARY: III. SLOWING THE GROWTH RATE. By R.D. Docter, K.P. Andersen, M.B. Berman, et al, dtd Sept.1972 - CH-129,867). Sept.1972. 60p.

Rand Corp.

Rand Corp.

Rand Corp.

NSF GI-44

R-1084-RSF/CSA

R-1115-RP/CSA

R-1116-RSF/CSA

Electricity

Power plants

Earth - Resources L-8-30-73

CH-129,867

1972

CALIFORNIA'S ELECTRICITY QUANDARY: III: SLOWING THE GROWTH RATE. R.D. Docter, K.P. Andersen, M.B. Berman, et al. (Prepared for the Calif. State Assembly). (This work is summarized in companion Rand Studies - R-1115-RP/CSA, "CALIFORNIA'S ELECTRICITY QUANDARY: II. PLANNING FOR POWER PLANT SITTING", by R.H. Ball, R.G. Salter, et al; R-1084-RSF/CSA, "CALIFORNIA'S ELECTRICITY QUANDARY: I. ESTIMATING FUTURE DEMANDS. W.E. Moos and C.C. Now, dtd Sept.1972 - CH-129,869). Sept.1972. 141p.

Rand Corp.

Rand Corp.

Rand Corp.

NSF GI-44

R-1116-RSF/CSA

R-1115-RP/CSA

R-1084-RSF/CSA

Electricity

Power plants

Earth -Resources L-8-29-73

1972

N74-15697# Chase Manhattan Bank, New York. Energy Economics Div.
OUTLOOK FOR ENERGY IN THE UNITED STATES TO 1985
 John G. Winger, Gerald D. Gunning, John D. Emerson, Richard C. Spaulding, and Arthur J. Zrally Jun. 1972 56 p
 Avail: NTIS HC \$5.00

The energy requirements of various sectors of the U.S. economy are analyzed. Graphs and charts are developed to show previous energy consumption levels and predictions are made for future requirements to 1985. A comparison is made for the amounts of energy in the form of oil, natural gas, coal, water, and nuclear used by various geographical areas of the United States. Tables of data are prepared to show the potential sources of energy, both foreign and domestic. The economic impact of depending on foreign sources for resources is analyzed.

Author

(HIT-498) **ELECTRICAL POWER SUPPLY AND DEMAND FORECASTS FOR THE UNITED STATES THROUGH 2050.**
 (Hittman Associates, Inc., Columbia, Md. (USA)). Feb 1972. 55p. (PB-209-266).

The historical growth of the demand for electrical power, the trends in selection of power plant fuels by geographic distribution, projections of power demand growth into the twenty-first century, and the potential impacts on national air quality resulting from the various alternatives of fuel usage are explored. In particular, power plants scheduled for construction from mid-1971 onward are surveyed to provide a basis for estimating the impact of national emission standards for sulfur dioxide on the electrical generating industry. Total installed power capacity will increase from about 320,000 MW in 1970 to about 1,000,000 MW in 1990, from about 1,500,000 in 2000, and 5,200,000 in 2050. Fossil fuels supplied about 83% of utility power in 1970. Fossil-fuel use will decrease to about 50% in 2000 and to about 11% in 2050, while nuclear power will increase from the present 3% to about 45% in 2000 and to about 88% in 2050. Barring any major unforeseen developments, such as cataclysm, catastrophe, or revolutionary scientific discovery, there appears to be reasonable certainty that national electrical power demands and supplies will approximate the growth curves delineated. (auth)

DOD, AIRLINES FACE ENERGY CRISIS.

M.L. Yaffee.

Aviation Week & Space Tech, Nov.20,1972, p.54,55,57.

Growing demand could force US to import more than 50% of its fuel needs in the 1980's; DOD feels economic crunch.

1972

Overview of Long Range Load Forecasting.

James B. Woodard.
 Massachusetts Inst. of Tech., Cambridge. Energy Analysis and Planning Group. Sep 72, 93p Working Paper-72-6.
 NSF-RA/N-72-031
 PB-227 686/3WE PC\$4.00/MF\$1.45

The working paper provides an overview of some of the important aspects of long range load forecasting in the electric utility industry. The paper considers the problems in predicting the future load and some of the techniques which have been proposed to deal with these problems.

ENERGY NEEDS: PROJECTED DEMANDS AND HOW TO REDUCE THEM. A.L. Hammond.
 Science, v.178, Dec.15,1972, p.1186-1188.

1972

ENERGY IN THE 1970'S: A SECOND LOOK. Weibold, J. F. (Office of Science and Tech., Washington, DC). pp 1180-1195 of 7th Intersociety Energy Conversion Engineering Conference, Washington; American Chemical Society (1972).

From 7th Intersociety energy conversion engineering conference; San Diego, California, USA (25 Sep 1972). See CONF-720925-

Environmental concerns dominated the 1970 energy picture, then turned to the basic economics of energy supply and demand. The National Environmental Policy Act of 1969, with its requirement for environmental impact statements has provided a vehicle for questioning federal actions involving nuclear power plants, other electric power facilities, off-shore oil and gas leases, oil shale development, and other energy technologies. The partnership between government and industry was given high visibility in the President's energy message of June 4, 1972. Each of the three priorities—the liquid metal fast breeder reactor, high-Btu-coal gasification, and sulfur oxide control technologies—is being developed in partnership with industry. New starts were made on several other energy technologies in the FY 73 budget. Additional energy technologies are being considered by a Federal Council for Science and Technology Energy R&D Goals Committee. Industry is also moving to increase its energy R&D efforts through the newly incorporated Electric Power Research Institute and other industry groups. (MCW)

54

N74-16660 Sun Oil Co., Philadelphia, Pa. Economics and Industry Affairs.
BALANCING THE DEMAND AND SUPPLY OF OTHER ENERGY FORMS
 James S. Cross. In Denver Univ. Balancing Supply and Demand for Energy in the US 1972 p 131-143 (For availability see N74-16651 07-34)

Methods for balancing the demand and supply of various energy forms are discussed. A graphic presentation of the U.S. energy balance for the five year periods beginning in 1970 and extending to 1985 is developed. The economic and environmental factors involved in using hydroelectric, geothermal, synthetic gas, and tar sands for energy sources are examined. Other sources of energy from agricultural products and tidal energy are analyzed. The potential for using more of the energy available from the sun is proposed.
 Author

ELECTRICITY DEMAND GROWTH AND THE ENERGY CRISIS, Duane Chapman

An analysis of electricity demand growth projections suggests overestimates in the long run

Science, v.178, no, 4062, Nov. 17, 1972, p.703-708

FUTURE SUPPLY AND DEMAND FOR ELECTRICITY IN CANADA. Bell, E. S. (National Energy Board, Ottawa); Shuter, G. Y. Eng. J. (Montreal); 55: No. 10, 12-11 Oct 1973).

Forecasts are made of electricity consumption in Canada until 2000 AD. The forecasts take account of a decrease in the birth rate of 17.3 per thousand in 1970. Forecast consumptions are 359 TWh in 1980 and 1,315 in 2000. The latter figure corresponds to 38 MWh/a per capita. Canada comes second only to Norway in consumption of electricity. Some possibilities for increased use of electricity in the home are indicated. New hydroelectric power sites will be developed in Manitoba, British Columbia, Yukon, Quebec and Labrador. Only in British Columbia will consumption of coal increase much. Ontario will achieve increased production of electricity mainly from nuclear energy. Nuclear capacities predicted for 2000 AD for Ontario, Maritimes, Quebec, Prairies, B. C. (and the territories) are 371, 18, 175, 0, 56 TWh/a; the corresponding figures for 1980 are 35, 0, 1.75, 0, 0. (CA)

N74-16651# Denver Univ., Colo. Petroleum Economics Inst.
BALANCING SUPPLY AND DEMAND FOR ENERGY IN THE UNITED STATES
 1972 166 p refs
 Avail: NTIS HC \$10.50

The proceedings of a conference on the problem of balancing supply and demand for energy in the United States are presented. The time span considered is from 1972 to 1985. The subjects discussed are: (1) U.S. energy demands based on population and economic growth, (2) government policies, national objectives, and the energy industries, (3) long run cost trends for energy sources, and (4) supply and demand aspects of oil, natural gas, coal, electricity, nuclear fuels, and other energy forms. One paper is directed toward the environmental protection and long run supply of crude oil in the United States. For individual titles, see N74-16652 through N74-16661.

TITLE: United States Energy, A Summary Review
NOTES: Energy Study Working Group
CORPORATE AUTHOR: U.S. Dept. of Interior
PUBLICATION DESCRIPTION: 82 p.
PUBLICATION DATE: 1972, January

ABSTRACT: This report summarizes more detailed studies, which are the basis for the decisions in the energy area made by the Department of the Interior. National objectives with respect to energy are studied, including the need for energy, national security, conservation, environmental control and improvement, consumer interests, and international relations. Forecasts of energy requirements are briefly summarized. The adequacy of energy resources and fuel supply problems are reviewed for electric power, coal, gas, petroleum, and other energy sources. (NPO)
AVAILABILITY: GPO (S.50)

(UCRL-51221) **ENERGY: USES, SOURCES, ISSUES.**
 Austin, A. L.; Rubin, B.; Werth, G. C. (California Univ., Livermore. Lawrence Livermore Lab.). 30 May 1972. 129p. Dep. NTIS.

Data on current and predicted future energy uses, costs, and sources are compiled as a reference for studies of the complex problems involved in providing the US with abundant supplies of low cost energy while minimizing the environmental effects of energy production and use. The data are presented in graphs or tables with the data sources itemized. (L.C.L.)

1972

N-129,712 92d Congress, 2d Session

ENERGY "DEMAND" STUDIES AN ANALYSIS AND APPRAISAL.

(Prepared for the Use of the Committee on Interior and Insular Affairs of the U.S. House of Representatives Sept.1972. (Committee Print).)

NTIS: United States Energy Through the Year 2000

AUTHOR: Daptee, W.G., Jr.; Vest, J.A.

CORPORATE AUTHOR: U.S. Dept. of Interior

PUBLICATION DESCRIPTION: Report, 80 p.

PUBLICATION DATE: 1972, December

ABSTRACT: Adequate and dependable quantities of fuels and energy in diverse forms are essential to the Nation's economy, security, and standard of living. In order to develop policies and plan programs to assure that energy requirements are most efficiently met, it is necessary to assess and forecast future energy demand and supply as accurately as possible. That is the main purpose of this paper. This report presents the results of comprehensive studies and analyses of the probable future energy consumption within each of the major consuming sectors and for each of the energy supply sources.

Technological, environmental, social, and other factors influencing future energy consumption were assessed and factored into the forecast and the "most probable" trends were identified and quantified insofar as possible. It follows an earlier Departmental publication, "U.S. Energy - A Summary Review" as the second in a planned series of reports to help an informed public to understand the dimensions of our present and future energy problems. (From FORWARD by Rogers C.B. Morton, Sect. of the Interior)

AVAILABILITY: U.S. Dept. of Interior, Office of Oil and Gas, Washington, D.C. 20240

Kelly, R., Reynolds, R. A., "Energy Supply and Demand Political Implications", General Electric TEMPO Report 72TMP-51, December, 1972.

1972

N74-15685# Geological Survey, Washington, D.C.

ENERGY RESOURCES OF THE UNITED STATES

P. K. Theobald, S. P. Schweinfurth, and D. C. Duncan 1972

30 p refs

ad40 CN-129,991

(CIRC-650) Avail: NTIS MF \$1.45; USGS HC no charge

The accompanying diagrams present the U.S. Geological Survey estimates of the United States resources of coal, petroleum liquids, natural gas, uranium, geothermal energy, and oil from specialists familiar with each of the energy sources, each using techniques he considers most useful for estimating his particular energy source. The short text accompanying each diagram outlines the method of estimation of the source of the estimate and defines the characteristics of each estimate. Where appropriate, comparisons with other estimates are also given. Resources, as used here, include all rocks and minerals (including their contained heat for geothermal sources) potentially usable by man. Author

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ENERGY RESOURCES: AN ELEMENT OF NATIONAL POWER.

Colonel William B. Handler.

Air University Review, Jan/Feb.1972, p.3-13.

(ORNL-ir-2779) UNDEVELOPED ENERGY RESERVES

FOR PRODUCTION OF ELECTRICAL POWER. Attempt at a Realistic Method of Consideration. Franzen, L. F.; Merton, A.

Institut fuer Reaktorsicherheit der Technischen Ueberwachungs-

Verneine e.V., Cologne (F.R. Germany)). Sep 1972. Translation

by R. G. Mansfield of IRS-S-7. 23p. Dep. NTIS \$3.25.

Energy reserves must be examined from two different view-

points--their natural occurrence and potentials for use. Solar

energy has an enormous, practically inexhaustible power potential.

The technology for its conversion to electrical energy is in its

infancy. Equipment already developed for this purpose is com-

plicated and cumbersome, has a poor efficiency, and is therefore

expensive. The power potential in water, at 2.9×10^6 MW, is large.

Although on a worldwide scale still largely unexploited, water

energy is nearly exhausted in industrial nations, especially Western

Europe. Tidal energy can be tapped on a large scale only in small

coastal areas. Nuclear fusion opens up excellent possibilities for

the future production of energy. Upon realization of the deuterium-

deuterium reaction, an enormous energy reserve will become

available. Along with the use of fossil fuels, whose contribution to

73V18443 1972 ISS 00 IJ153.C433 333.82C973 LC-72-95545

MEETING NATIONAL ENERGY NEEDS.

CHAMBER OF COMMERCE OF THE UNITED STATES OF AMERICA. COMMUNITY AND

REGIONAL DEVELOPMENT GROUP.

WASHINGTON, 51 P. ILLUS. 28 CM.

\$4.00

LC POWER RESOURCES -- UNITED STATES.

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MAIN-CORP TRACE-TITL* CAILG BY-LC

CM-129,122,pt.4

(1972)

THE NATIONAL POWER SURVEY - 1970. PART IV. (GUIDE-
LINES FOR GROWTH OF THE ELECTRIC POWER INDUSTRY).
(Technical Advisory Committee Reports to the Federal
Power Commission - prepared by The Generation
Technical Advisory Committee; The Transmission
Technical Advisory Committee; The Distribution
Technical Advisory Committee and The Technical
Advisory Committee on Load Forecasting Methodology).
(1972).

Federal Power Commission

Power sources

Power plants

Power transmission

Electricity

National Power Survey

L75,945/305

L-9-6-73

CM-129,122,pt.1

1971

THE NATIONAL POWER SURVEY - 1970. PART I. (GUIDELINES
FOR GROWTH OF THE ELECTRIC POWER INDUSTRY). (Report
of the Federal Power Commission (includes an
independent report of Task Force on Environment)).
1971.

Federal Power Commission

Power sources

Power plants

Electricity

National Power Survey

Power sources

L75,945/305

1971

THE ENERGY RESOURCES AND ELECTRIC POWER SITUATION IN
THE UNITED STATES.

M. Altman, et al.

Energy Conversion, v.12, 1972, p.53-64.

U.S. ENERGY OUTLOOK--AN INITIAL
APPRAISAL 1971-1985. The first volume of the report
projects supply/demand relationships for the period
1971-1985, assessing minimal changes in the economic
climate of the energy industries and in government
policies and regulations concerning those industries.
The second volume contains summaries of the detailed
reports prepared by the group's energy demand, oil, gas
and other energy resources subcommittees of the NPC
Committee on U.S. Energy Outlook. Charts indicating
the key findings of the individual fuel groups are
attached.

Rep. National Petroleum Council, Washington, DC.
Interim Report, v.1, Jul 1971, 75 p. v.2. Summaries of
Task Group Reports, Nov 1971, 195 p.

CM-129, 656 *Energy consumption* 1971
THE U.S. ENERGY PROBLEM. VOLUME I: SUMMARY VOLUME.
G.C. Szego. (Final rept.). Nov. 1971. 67p.

InterTechnology Corp. ITC C-645, v.1
National Science Foundation NSF-RANN-71-1-1
National Technical Information Service PB 207 517
NSF C-645

Power sources

Summarizes a study to guide choice of priorities in energy-related research and development offered for government support. Major outputs are a detailed costing, modeling and the determination of the influence coefficients of technologies on the cost of energy, primarily electricity. The status and probable trends of important elements in the energy economy is presented, as well as the state of the art and the economics of various alternative means of energy conversion.

N74-11796J InterTechnology Corp., Warrenton, Va.
THE U.S. ENERGY PROBLEM. VOLUME 2: APPENDICES.
PART A. Final Report, Dec. 1970 - Nov. 1971
G. C. Szego 1971 745 p refs 2 Vol.
(Grant NSF C-645)
(PB-207518; NSF-RANN-71-1-2) Avail: NTIS HC\$12.50 CSCL 10B

The energy status and outlook for the United States and the World are analyzed. A simulation model of fossil fuel steam electric generating plants is developed. The model includes the following features: (1) cost tradeoff analysis, (2) influence coefficients, (3) cost reduction versus technology, (4) cost of fossil fuels, (5) magnetohydrodynamic topping, (6) nuclear energy, (7) residential energy analysis, and (8) solar energy. Author

N74-11796J InterTechnology Corp., Warrenton, Va.
THE U.S. ENERGY PROBLEM. VOLUME 2: APPENDICES.
PART B. Final Report, Dec. 1970 - Nov. 1971
G. C. Szego Nov. 1971 886 p refs 2 Vol.
(Grant NSF C-645)
(PB-207519; NSF-RANN-71-1-3) Avail: NTIS HC\$12.50 CSCL 10B

An analysis of the energy requirements and energy sources for the United States is presented. The subjects discussed are: (1) off-peak storage, (2) state of electrochemical research and development of fuel cells, (3) alternate energy conversion cycles, (3) effects of failures of cryogenic superconductivity on electrical transmission lines, (4) transportation requirements, (5) environmental factors, (6) future investment capital for public utilities, (7) supply and demand analysis for energy related minerals, (8) econometric model for primary industries, (9) technology of alternate fuels, (10) a petroleum refinery model, and (11) the current state of thermionic energy conversion technology. Author

CM-127, 069, Mag. 1971
SOME FUTURE DIMENSIONS OF ELECTRIC POWER GENERATION.
CIRCA 1970-1990. P.W. Ross and L.G. Hauser.

Westinghouse Engineer, v.31, Jan. 1971
no.1, p.2-7

Power plants
Generators, Electric
Fuels
Coal

L-2-23-71

N71-35501 National Lending Library for Science and Technology, Boston Spa (England)
PROGNOSIS OF THE WORLD ENERGY SUPPLY BETWEEN NOW AND THE YEAR 2000 WITH REFERENCE TO THE QUANTITY OF ENERGY RAW MATERIALS CONSUMED
Th. R. Seldenthuis 12 Mar. 1971 23 p Transl into English from Chem. Weekbl. (Netherlands), v. 66, no. 44, 30 Oct. 1970 p.20-26
(NLL-Trans-1166-19022.9) Avail: Natl. Lending Library, Boston Spa, Engl.; 2 NLL photocopy coupons

A statistical assessment is presented of the nuclear energy, solid fuel, petroleum, natural gas, and water power energy resources in the year 2000. The analysis is based on current economic and technical trends in the world energy consumption and not on potential primary energy sources such as solar radiation or heat from the interior of the earth or potential advancements in reactor technology. J.G.M.

ENERGY IN PERSPECTIVE.

L.P. Gaucher.

Chemtech, Mar. 1971, p.153-158.

The entire energy crisis is placed in perspective by examination of the history of energy consumption in all its forms. Prognostications are then made beyond the usual cut-off date of the year 2000. There is a strong implication that an energy source that is not now in use will be required in the foreseeable future.

1971

(RNL-SA-4060) EVALUATION OF ENERGY
**GROWTH AND USE TRENDS AS A POTENTIAL UPPER LIMIT IN
 METROPOLITAN DEVELOPMENT.** Jaske, R. T. (Battelle
 Pacific Northwest Labs., Richland, Wash.). 8 Oct 1971. Con-
 tract AT(45-1)-1830. 31p. (CONF-711022-3). Dep. NTIS
 \$3.75.

From 2nd annual thermal power and 8th biennial hydraulics
 conference; Pullman, Washington, USA (5 Oct 1971).
 The case of energy use and distribution, as forecast from a
 composite of authoritative United States sources, illustrates that
 the extent of energy concentration in large metropolitan areas is
 expected to reach significant fractions of the solar input to the
 Earth's surface. Examinations of total energy release suggest
 direct relationship in weather modification of metropolitan areas
 such that mean temperature are increasing, cloudiness is in-
 creased, and total precipitation markedly increased. A tentative
 solution appears to include emphasis on metropolitan de-concen-
 tration of energy, people, and general industrial activity. A num-
 ber of other alternatives such as higher rates, improved efficiency
 of generation and usage, and financial means of regulating supply,
 demand, and effects could also be suggested. Indispensable to all
 of these must be the development of a national land use policy.
 (JCW)

AN ENGINEER LOOKS AT THE ENERGY DILEMMA.

R.W. Graham, LeRC.
 Mechanical Engineering, v.93, no.2, Feb.'71, p.40-46.

- Trends in energy consumption.
- Electric power consumption.
- Means for producing energy.
- Courses of action.

74N71019 71/10/00 74 PAGES UNCLASSIFIED DOCUMENT
 US ENERGY A SUMMARY REVIEW
 INTERIOR DEPT., WASHINGTON, D.C. AVAIL. NTIS
 /*COST ANALYSIS/*ENERGY REQUIREMENTS/*ENVIRONMENT EFFECTS/ ENERGY
 SOURCES/ FUEL CONSUMPTION/ RESOURCE ALLOCATION

1971

PA-208 238
 Environmental Protection Agency, Research Tri-
 angle Park, N. C. Office of Air Programs.
**AN ANALYSIS OF THE ENERGY/FUELS
 SUPPLY AND DEMAND SITUATION IN
 SELECTED AIR QUALITY CONTROL RE-
 GIONS OF THE NORTHEAST CORRIDOR.**

May 71, 127p * APTD-0977

Descriptions: (*Electric power demand, *Fuel con-
 sumption), (*Fuels, *Reserves), (*Supply
 (Economics), Fuels), Fossil fuels, Fuel oils,
 Residual oils, Natural gas, Thermal power plants,
 Nuclear power plants, Air pollution, Abatement,
 Fossil fuel deposits, Coal, Economic analysis, De-
 mand (Economics), Taxes, Sulfur.
 Identifiers: *Northeast Corridor, *Air pollution
 abatement, *Low sulfur fuels, Air pollution
 economics.

The report examines the energy requirements and
 supplies (especially fossil fuels) needed to jointly
 meet both energy and air quality requirements in
 seven air quality control regions within the
 Northeast Corridor during the 1970-1975 period.
 The Northeast Corridor includes the east coast of
 the United States from Boston to Washington.
 This area encompasses all or at least a major part
 of the air quality control regions of Boston,
 Philadelphia, Baltimore, and Washington. The es-
 sential purpose of the study is to identify major
 gap areas in near term fuel use and projected
 supply requirements considering both the need for
 energy and the need for environmental protection.
 An equally important objective is to provide
 recommendations with respect to specific steps
 needed to be taken in order to fill energy gaps in an
 environmentally acceptable manner as revealed by
 the study. (Author)

1971

N74-18609# United Nations, New York. Economic and Social Council.

NATURAL RESOURCES DEVELOPMENT AND POLICIES INCLUDING ENVIRONMENTAL CONSIDERATIONS. ADDENDUM: CHANGING PATTERNS IN THE WORLD ENERGY SITUATION

12 Jan. 1971 40 p refs

(E/C/2/Add.1) Avail: NTIS HC \$5.00

The consumption and production of energy worldwide are cited. Special attention was given to the close interrelationship between energy use and economic development. Energy demand as affected by industrialization, urbanization, and mechanization are discussed. Statistical tables covering consumption and energy supplies from 1950 to 1968 are included. E.H.W.

N72-16982# United Nations, New York. Dept. of Economic and Social Affairs.

WORLD ENERGY REQUIREMENTS AND RESOURCES IN

THE YEAR 2000

Jul. 1971 21 p refs Presented at the 4th Intern. Conf. on the Peaceful Uses of Atomic Energy, Geneva, 6-16 Sep. 1971 (A/Conf-49/P-420; Conf-710901-439) Avail: AEC Depository Libraries

Existing long-term projections of energy demand at global and regional levels are reviewed. Long term factors influencing the demand for energy in countries in various stages of socio-economic development are assessed. Likely shifts in the demand for energy over the long term period in the light of various assumptions relating, among others to prospective economic growth rates, and to technological changes and innovations that may produce major shifts in the long term pattern of energy consumption are identified. Author (NSA)

7+N71343 71/CG/00 17+ PAGES UNCLASSIFIED DOCUMENT

A REVIEW OF THE ENERGY RESOURCES OF THE PUBLIC LANDS, BASED ON STUDIES SPONSORED BY THE PUBLIC LAW REVIEW COMMISSION

COMMITTEE ON INTERIOR AND INSULAR AFFAIRS (U. S. SENATE).; LIBRARY OF CONGRESS, WASHINGTON, D.C. AVAIL COMM. ON INTERIOR AND INSULAR AFFAIRS

WASHINGTON GPC PREPARED BY LIBRARY OF CONGR. PRESENTED TO COMM. ON INTERIOR AND INSULAR AFFAIRS, 92ND CONGR., 1ST SESS., 1 OCT. 1971

/*CONGRESS/*ENERGY POLICY/*ENERGY SOURCES/ COAL/ CONTINENTAL SHELVES/ CRUDE OIL/ URANIUM

N72-16981# RWE-Aktiengesellschaft, Essen (West Germany). RESOURCES OF PRIMARY ENERGY

Heinrich Mandel 24 Feb. 1972 27 p refs Presented at 4th Intern. Conf. on The Peaceful Uses of Atomic Energy, Geneva, Switzerland, 6 Sep. 1971

(A/Conf-49/P/359; Conf-710901-123) Avail: AEC Depository Libraries

The fossil fuels should be sufficient for about 480 years, the basic materials for nuclear fission even sufficient for 25,000 years. This consideration, however, leads to false conclusions. It is necessary to take into account the world's population growth as well as the increasing per capita consumption. The result is that the reserves of fossil fuels would be sufficient for some more years only towards the end of the 21st century, whereas nuclear fuels would suffice for about 300 years. This means that, on one hand, the world will be dependent upon nuclear fusion at long sight, but that, on the other hand, sufficient time will be left to develop it. Author (NSA)

N72-20949# RAND Corp., Santa Monica, Calif. SIGNED DIGRAPHS AND THE GROWING DEMAND FOR ENERGY

Fred S. Roberts May 1971 52 p refs (Grant NSF GI-44)

(R-756-NSF) Avail: NTIS

An outline is given of a methodology which exploits the signed digraph for handling problems of forecasting energy demand and the effect of new technologies and institutions on that demand, and for generating and analyzing policy alternatives for meeting environmental constraints on energy use. The forecasting and policy problems are translated into signed digraph problems, and in particular to problems of so-called pulse processes on signed digraphs. Research problems related to the development of the methodology are described. Author

73V11662 1970 ISS 00 JX1977.A2S1/STAT SER.J/13 338.2 LC-00-00000

NASA HQ. 5224

WORLD ENERGY SUPPLIES, 1965-1968

UNITED NATIONS NEW YORK

U.N. STATISTICAL OFFICE. STATISTICAL PAPERS, SER. J, NO.13 200

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LC POWER RESOURCES

NASA / COAL/ COKE/ COMMERCE/ CRUDE OIL/ ENERGY/ FUEL CILS/ CUTPUT/

POWER/ ELECTRIC POWER/ FUEL CONSUMPTION

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73V21699 1970 ISS QC IP317.A8C 157C Q-909812-00-4 602.60994

LC-72-178624

THE ASSESSMENT OF OUR FUEL AND ENERGY RESOURCES AND REQUIREMENTS;

... COLLECTED PREPRINTS OF PAPERS PRESENTED.

CONFERENCE ON THE ASSESSMENT OF OUR FUEL AND ENERGY RESOURCES AND

REQUIREMENTS, BRISBANE, 1970.

INSTITUTE OF FUEL, AUSTRALIAN MEMBERSHIP, SYDNEY? 1 V. (VARICUS

PAGINGS) DIAGRS., GRAPHS, MAP, TABLES. 28 CM.

"ERRATA" LEAF INSERTED. INCLUDES BIBLIOGRAPHICAL REFERENCES.

LC FUEL -- AUSTRALIA -- CONGRESSES.

ADDED U#AT** INSTITUTE OF FUEL, LONDON. AUSTRALIAN MEMBERSHIP.

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/ / PUBL IN AUSTRALIA

74N71015 70/12/00 26 PAGES UNCLASSIFIED DOCUMENT

THE ENERGY SUPPLY PROBLEM

AMERICAN PETROLEUM INST., NEW YORK. AVAIL.NTIS

/#ENERGY CONSUMPTION/#ENERGY REQUIREMENTS/#ENERGY SOURCES/ EARLY

RESOURCES/ ENERGY POLICY

74N71307 70/00/00 528 PAGES UNCLASSIFIED DOCUMENT

THE IMPACT OF THE ENERGY AND FUEL CRISIS ON SMALL BUSINESS

SELECT COMMITTEE ON SMALL BUSINESS (U. S. HOUSE). AVAIL SUBCCMM.

ON SPEC. SMALL BUSINESS PROBLEMS

WASHINGTON GPO HEARINGS BEFORE SELECT COMM. ON SMALL BUSINESS,

91ST CONGR., 2ND SESS., 6-8 OCT. 1970

/#ELECTRIC POWER SUPPLIES/#ENERGY CONSUMPTION/#INDUSTRIES/

ENVIRONMENT PROTECTION/ GOVERNMENT/INDUSTRY RELATIONS/ POLICIES

Technology Assessment with Special Reference to Energy.

C. L. Comar.
Cornell Univ., Ithaca, N.Y. Cornell Energy Project. Oct 70.
40p Paper-70-1, NSF-RA/N-70-001
PB-228 863/7WE PC\$5.00/MF\$1.45

The long-term and short-term implications of society's need for energy are discussed in terms of the necessity to assess biological costs of energy production, the need to maximize benefits and minimize costs, and to discover the price society is willing to pay for the energy it wants or needs. Various aspects of energy production are covered, such as: amount used per person; functional allocation; sources; available reserves; ultimate limits; increase in demand; heat disposal problems; radioactive wastes and the effects of air pollution. Comparative risk assessments are made between voluntary-in-voluntary actions as compared to risks of radiation from fallout and nuclear plants, along with cost in terms of risk of death versus financial benefit to the individual and the cost of deaths averted through medical and other programs. The need for logical decisions on the priorities and choices of options (based on cost-benefit analyses) is stressed, as is the need for guiding principles for reduction of environmental effects from energy production. (Author)

POWER GENERATION: THE NEXT 30 YEARS.

R.W. Holcomb.
Science, v.167, Jan.9,1970, p.159-60.

1969
CN-129,122,pt.3
THE 1970 NATIONAL POWER SURVEY. PART III: ELECTRIC POWER IN THE SOUTH CENTRAL REGION 1970 - 1980 - 1990.
(A report to the Federal Power Commission prepared by the South Central Regional Advisory Committee of the FPC). Feb.1969.

Federal Power Commission

Power sources
Power plants
Electricity

National Power Survey
(South Central, West Central, West Region)
L-11-21-72

62

1969
N89-38674# Royal Inst. of Tech., Stockholm (Sweden). Div. of Plasma Physics.
THE FUTURE ENERGY SUPPLY OF THE WORLD
B. Lehnert Apr. 1969 7 p refs
(Rept-69-11) Avail: CFSTI

The available data and energy consumption predictions indicate that conventional energy supplies will become insufficient during the first half of the next century and this crisis can only be avoided by the use of nuclear sources. The transition to nuclear power is discussed and it is shown that research and development of breeder and/or fusion reactors should be intensified. ESRO

N70-37343# Battelle Memorial Inst., Richland, Wash. Pacific Northwest Labs. Also CN-129 629
A REVIEW AND COMPARISON OF SELECTED UNITED STATES ENERGY FORECASTS
Dec. 1969 96 p Prepared for the Executive Office of the President. Office of Sci. and Technol.
(PB-189938) Avail: \$1.00; CFSTI CSCL 05A

The report collects in a single volume the essence of nineteen energy forecasts published in recent years by private organizations, government agencies, and individuals and compares their forecast values, assumptions, and methodologies. The study evaluates existing energy forecasts for policy planning purposes. The forecasts were prepared for different purposes and often reflect differences in terminology, coverage, and assumptions. The comparative tables in the report take these differences into account insofar as possible. USGRDR

PB-207 EIS
Bureau of Mines, Washington, D.C.
AN ENERGY MODEL FOR THE UNITED STATES. FEATURING ENERGY BALANCES FOR THE YEARS 1947 TO 1965 AND PROJECTIONS AND FORECASTS TO THE YEARS 1980 AND 2000.
Information circular,
Warren E. Morrison, and Charles L. Reading. Jul 68, 136p BuMines-IC-8384
PC\$3.00/MF\$0.95

Descriptors: (*Energy, Resources), Reserves, Forecasting, Mathematical models, Requirements, Supply (Economics), Demand (Economics), Coal, Natural gas, Crude oil, Fossil fuels.

A simplified energy model for the United States is quantified for a recent historical period. The basic model and calculated quantified structures are used for a number of analytical case studies that estimate midterm and long-range shifts in patterns of energy resources demand and required supply. Historical data series are presented for the years

1947 to 1965 in the form of integrated energy balances by source, form, and consuming sector. In case studies 1 to 12, conditional projections of historical trends of energy demand and required supply are made for the midterm period 1966 to 1980. The projections are carried out by correlation of major energy components with relevant independent variables such as major economic indicators. Simulations of the medium-range projections to 1980 are carried out by varying the assumptions for the determining variables to produce high- and low-range projections for the midterm period. Case studies 13 to 22 are long term contingency or technological forecasts to the year 2000. (Author)

1968

DN-129,122,pt.2
 1968
 THE 1970 NATIONAL POWER SURVEY. PART II: ELECTRIC
 POWER IN THE NORTHEAST 1970 - 1980 - 1990. (A report
 to the Federal Power Commission prepared by the
 Northeast Regional Advisory Committee of the FPC).
 Dec.2,1968.

Federal Power Commission

Power sources

Power plants

Electricity

National Power Survey

(Northeast, East Central, Southeast, and Fossil Fuels).
 L-11-21-72

WORLD PROSPECTS FOR NATURAL RESOURCES.
 Some Projections of Demand and Indicators of Supply to the Year
 2000. Fisher, J. L.; Potter, Neal. Washington, D. C.; Re-
 sources for the Future, Inc. (1964). 77p. Johns Hopkins Press,
 Baltimore.

Information and discussions on natural resources are pre-
 sented in chapters on resource adequacy, resources in the U.S.,
 world trends in resources, projection of resource demands,
 reserves and supply possibilities, and overall estimations.
 (U.R.D.)

74N71344 64/10/00 318 PAGES UNCLASSIFIED DOCUMENT

NATIONAL POWER SURVEY, PART 1

FEDERAL POWER COMMISSION, WASHINGTON, D.C.

/#ELECTRIC GENERATORS/*ENERGY REQUIREMENTS/ COSTS/ HYDROCARBON

FUELS/ HYDROELECTRIC POWER STATIONS/ NUCLEAR FUELS/ TECHNOLOGY

ASSESSMENT

74N71345 64/10/00 426 PAGES UNCLASSIFIED DOCUMENT

NATIONAL POWER SURVEY. PART 2 ADVISORY REPORTS

FEDERAL POWER COMMISSION, WASHINGTON, D.C.

/#ELECTRIC GENERATORS/*ELECTRIC POWER TRANSMISSION/ HYDROCARBON

FUELS/ HYDROELECTRIC POWER STATIONS/ NUCLEAR FUELS

74N72828# PB-222401/2 NAS-NRC-PUB-1000-D LC-63-60C11 62/12/00 153

PAGES UNCLASSIFIED DOCUMENT

ENERGY RESOURCES A REPORT TO THE COMMITTEE ON NATURAL RESOURCES OF

THE NATIONAL ACADEMY OF SCIENCES-NATIONAL RESEARCH COUNCIL

A/HUBBERT, M. K.

NATIONAL ACADEMY OF SCIENCES - NATIONAL RESEARCH COUNCIL,

WASHINGTON, D.C. AVAIL. NTIS

/#ELECTRIC POWER SUPPLIES/*ENERGY REQUIREMENTS/*FUEL CONSUMPTION/

COAL/ CRUDE OIL/ FOSSIL FUELS/ GEOTHERMAL RESOURCES/ NATURAL GAS/ SOLAR

ENERGY

C. POLICY, LEGISLATION, AND REGULATION

1974

US energy policy evaluation: some analytical approaches
Dilip R. Limaye and John R. Sharkey

Evaluating all the implications of specific changes in energy policy requires a comprehensive analysis of the complex interactions and interrelationships of energy supply, demand and prices. In this article, the authors discuss the general use of analytical approaches to energy policy evaluation and review specifically some of the techniques in the Total Energy Resource Analysis (TERA) model which has been developed for the US gas industry to assist in evaluating policy issues relative to gas supply and demand.

Energy Policy, v.2, no.1
Mar.1974, p.3-

1974

ENERGY POLICY IN THE U.S.

D.J. Rose.

Sci. Amer., v.230, no.1, Jan.1974, p.20-29.

The President's appeal for U.S. energy self-sufficiency by 1980 cannot be regarded as realistic. The long-range options that are open to the nation are here considered in a taxonomic approach.

Science, v.184, no.4134, Apr.19, 1974.

POLICY

Multiple Failures of Public and Private Institutions: P. Sporn 284

Interviews

The Executive: William E. Simon: J. Walsh and P. H. Abelson 287

The Congress: Senator Henry M. Jackson: R. Gillette and L. J. Carter 291

An Integrated National Energy Research and Development Program: P. L. Auer 295

Florida: An Energy Policy Emerges in a Growth State: L. J. Carter 302

N74-17669# Committee on Interior and Insular Affairs (U. S. Senate).

A REVIEW OF ENERGY POLICY ACTIVITIES OF THE 92D CONGRESS

1973 87 p refs Presented to Comm. on Interior and Insular Affairs, 93d Congr., 1st Sess., 30 Dec. 1972 Prepared by Library of Congr.

Avail: Comm. on Interior and Insular Affairs

The provision of an adequate supply of all needed forms of energy at reasonable and stable prices, with incentive for their continued adequate provision, without degradation of the environment or jeopardy to the national security, and with minimum waste is discussed. Three basic areas are discussed: the legislation that was enacted; the legislation that was proposed but not enacted; and the hearings that were held by the various committees and subcommittees of the Congress. In addition, reports concerning energy that were issued are included. Author

FEDERAL ENERGY ADMINISTRATION ACT (1973).
Hearings Before the Committee on Government Operations, United States Senate, Ninety-Third Congress on S. 2776, to Provide for the Effective and Efficient Management of the Nation's Energy Policies and Programs, December 6 and 7, 1973. Washington, DC: Committee on Government Operations (1974). 284p. GPO.

Hearings were held on S2776, a bill to provide effective and efficient management of the Nation's energy policies and programs. The bill embodies the President's proposal to establish a new Federal Energy Administration which will be the principal organization within the Federal Government for the formulation and implementation of policies and programs designed to meet the energy crisis. This proposed new agency is expected to develop and integrate domestic and foreign policies relating to energy resource management; develop and implement programs for dealing with energy production shortages, such as fuel allocation, surcharges, and rationing; develop and implement voluntary and mandatory energy conservation programs and promote efficiencies in the use of energy resources; develop and promulgate energy price regulations; develop and recommend policies on import and export of energy resources; facilitate implementation of the President's program to develop the potential for energy self-sufficiency; collect, evaluate, assemble, and analyze energy information on reserves, production, and demand and related economic data; and work with industry, State, and local governments and the general public on energy resource management. (MCW)

1974

Nature, v.249, June 21, 1974, p.698-700.

Towards rational energy policies

Lord Robens

Vickers House, Millbank Tower, Millbank, London SW7P 4RA, UK

"It is nonsensical to treat coal, gas, electricity, oil and nuclear energy as separate fuels without regard to the overall needs of Britain, and that is what has happened up to now. We should set up a National Fuel and Power Council to develop a coordinated and comprehensive policy for all the industries concerned".

FLORIDA: AN ENERGY POLICY EMERGES IN A GROWTH STATE. Carter, L. J. Science; 184: No. 4134, 302-305 (19 Apr 1974).

Florida's consumption of electricity has been increasing at an annual rate of 11%, as opposed to 7% for the nation. Air conditioning in residences and tourist accommodations and the great increase in population with the migration of 6000 people to the state each week, have resulted in the formulation of new energy policies. Gross energy consumption per capita is lower, but energy consumption for transportation per capita is 5% higher than the national average. The establishment of an energy policy committee was formed in the spring, 1973. Environmental land and water management laws were enacted in 1972 following the threat posed by the onrush of development to Florida's delicate hydrologic and ecologic systems pointed out by a severe drought. The recommendations for curbing the rising demand for energy, especially in those regions under increasing environmental stresses, are described. (MCW)

A Rational Energy Policy.

Coleman Raphael.

Atlantic Research Corp., Alexandria, Va. Apr 74, 64p

ARC-P1-1

PB-231 913/5WE PC\$3.25/MF\$1.45

The report analyzes the overall energy problem, defining the 'crisis', its causes, and the alternative solutions which are available. Conclusions drawn throughout the report are then brought together to form a rational and cohesive recommended program.

HIGHLIGHTS OF ENERGY LEGISLATION IN THE NINETY-THIRD CONGRESS, FIRST SESSION. A Background Paper Prepared by the Congressional Research Service at the Request of Henry M. Jackson, Chairman, Committee on Interior and Insular Affairs, United States Senate, Pursuant to S. Res. 45. A National Fuels and Energy Policy Study, Serial No. 93-38 (92-73). Washington, DC; Committee on Interior and Insular Affairs (1974). 120p. GPO \$1.15.

A summary is presented of the congressional action taken on energy-related issues during the 93rd Congress, 1st Session. Legislation enacted included petroleum allocation; Alaska pipeline; daylight saving time; speed limit reduction; rural electrification; oil pollution; and EURATOM cooperation. Major energy legislation receiving House or Senate passage included energy research and development; energy conservation; conservation in federal facilities; Energy Research and Development Administration; Federal Energy Emergency Administration Act; energy emergency; Clean Air Act amendments; naval petroleum reserves; deepwater ports; Council on Energy Policy; strip mining; land use planning. Other energy measures involved Department of Energy and Natural Resources; Federal Oil Corporation; Energy Information Act; energy supply; power plant siting; and natural gas deregulation. Energy-related legislation receiving action and copies of bills enacted are included in appendices. (MCW)

TITLE: Exploring Energy Choices - A Preliminary Report

COMPILING AUTHOR: Ford Foundation. Energy Policy Project

ADDRESS: 177A Massachusetts Avenue NW,

Washington, DC 20036

PUBLICATION DISPOSITION: 61 p. report

PUBLICATION DATE: 1974

ABSTRACT: This report is a preliminary overview of the work of the Energy Policy Project and provides a framework for thinking about energy policy. To analyze energy policy options, three descriptions, or scenarios, of the future are presented. The first one, called "historical growth", assumes that the use of energy will continue to grow as it has in the past. In the "technical fix" scenario, energy demand is reduced by applying energy saving technologies. The third scenario is "zero energy growth". This does not preclude economic growth, but would emphasize durability rather than disposability of goods and would substitute the ethic that "enough is best" for the idea that "more is better". Before presenting the scenarios for the future, the current energy situation is reviewed including the objectives, tools, and constraints of energy policy, energy policy in the world arena, environment and energy, federal energy resources, and choices and limits available in the next few years. (RPS)

AVAILABILITY: Energy Policy Project, P.O. Box 22212, Washington, DC 20028 (\$5.75 a copy/\$6.60 a copy for orders of 50 or more)

Exploring Energy Choices

A Preliminary Report
of the Ford Foundation's
Energy Policy Project

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ENERGY POLICY FACES LIMITED CHOICES. Smil, V. (Univ. of Manitoba, Winnipeg). Energy Int.; 11: No. 3, 18-19 (Mar 1974).

The view is presented that there is no shortage of energy for future generations. Fossil fuels and nuclear fission are the two available alternatives to meet the needs presently. The reserves of hydrocarbons are in tars, sands, and shales, but availability hinges on technologies and immense capital outlays. Exhaustion of all recoverable stocks of crude oil and natural gas will be a relatively fast phenomenon. Fast breeder reactors, thermonuclear fusion, solar conversion, and geothermal energy are new rational options with limitations. Controlled fusion, while theoretically feasible, poses an array of problems. Time lags and difficulties accompany the implementation of new energy and energy-related technologies such as MHD, high-Btu coal gasification, and SO₂ removal. Self-burial for high-activity radioactive effluents, hydrogen for portable energy needs, or low thermal ocean differences for power generation are decades away. (MCW)

TITLE: The Energy 'Crisis' and U.S. Foreign Policy
AUTHOR: Hunter, R.Z.
CORPORATE AUTHOR: Overseas Development Council
ADDRESS: Washington, DC
PUBLICATION DESCRIPTION: Headline Series. No. 216. 79 p.

PUBLICATION DATE: 1973, June
SPONSOR: Foreign Policy Association
ABSTRACT: This study focuses on the international dimensions of the energy problem. Particularly on supply, security, and cost. The domestic aspects of energy supply and demand are reviewed briefly. Information on importing fossil fuels is provided, followed by discussion of the role of the Soviet Union in the energy picture and the effect of the Arab-Israeli conflict. Methods of securing cooperation with other countries are analyzed, and the price we must pay for self-sufficiency is discussed. A number of suggestions for a domestic and foreign energy policy are outlined. The report concludes that we must keep the supply and price of energy in perspective. A lasting solution will not come from technology but from politics, including the domestic politics of conservation and our evolving relations with other countries. (MFB)

AVAILABILITY: Foreign Policy Association Inc., 345 W. 36th St., New York, NY 10017 (\$1.25)

N74-21619# Mitre Corp. McLean, Va.
BACKGROUND MATERIAL FOR THE ENERGY POLICY WORKSHOP, 11-12 JANUARY 1973
Richard S. Greeley Feb. 1973 79 p
(M73-12) Avail: NTIS HC \$7.00

A specific set of energy policies focused on achieving competitive fuel prices, increased domestic fuel supplies, and environmental protection is discussed. A set of charts containing background information on current and projected fuels availabilities and prices and a narrative discussion of each one is presented.

Author

TITLE: Land Use, Energy Flow, and Decision Making in Human Society - Second Year-End Report, Volume 1, Overview of Project
AUTHOR: Batt, K.; Brewer, J.; Bryan, S.
CORPORATE AUTHOR: University of California, Davis, Interdisciplinary Systems Group
ADDRESS: Davis, CA 95616
PUBLICATION DESCRIPTION: Report No. SSP 01-27, 95 p.

PUBLICATION DATE: 1973, January
SPONSOR: National Science Foundation, RANN Program
ABSTRACT: The overall objective of this work is to develop simulation models of land use and energy flow in human society, with special attention to the State of California. The models are being developed in an attempt to quantify the effects of alternative policy options available to decision makers. Since most land use and economic growth decisions are made at the city-county level of government and industry, a major model is being developed at this level. This model, when completed, will determine the impacts of various economic and population growth policy options on energy use, land use, pollution levels, and local governmental expenditures. A separate, more aggregated model is being developed to determine the impacts of various statewide land use policies on the rate of conversion of prime agricultural land for urban use and resource depletion. A global model is also under development to determine the impacts of various pollution sources on the physical and biotic environments. This volume presents an overview of the entire project including significant results and problems, interaction with user groups, and summaries of the various projects and models under development. (Auth. from Introduction)

N74-20613# Office of the White House Press Secretary,
Washington, D.C.

**[NATIONAL ENERGY POLICY FOR MEETING US ENERGY
REQUIREMENTS]**

Richard Nixon 18 Apr. 1973 19 p

Avail: NTIS HC \$4.00

The President's energy policy proposals to Congress on April 18, 1973 are presented. Recommendations were made for the increased production of energy as well as more judicious use of energy resources. The following specific actions were proposed: (1) increased production and use of natural gas; (2) utilization of the oil and gas resources of the Outer Continental Shelf; (3) construction of the Alaska pipeline; (4) development of shale oil; (5) increased utilization of geothermal resources; (6) expanded development and utilization of coal resources; (7) rapid development of nuclear power plants; and (8) exploration of domestic mineral resources. The development of deepwater ports for facilitating imports was also recommended. The establishment of the Federal Energy Organization was outlined. S.K.W.

PRESIDENTIAL ENERGY STATEMENTS. Printed at the Request of Henry M. Jackson, Chairman, Committee on Interior and Insular Affairs, United States Senate, Ninety-Third Congress, First Session, Pursuant to S. Res. 45, a National Fuels and Energy Policy Study. Washington, DC; Committee on Interior and Insular Affairs (1973). 112p. GPO \$1.05.

A collection of the messages, statements, and speeches made by President Nixon on the energy issues are compiled and published for the use of Senators participating in the National Fuels and Energy Policy Study. (MCW)

**ENERGY REPORT/SWEEPING NEW ENERGY POLICIES MOVE
TOWARD APPROVAL THIS SUMMER.** C.E.Barfield.
Nat. Jour. Rept., 6/29/74, p.963-968.

Two major energy bills are ready for final floor action in July and leaders in Congress and officials in the Administration say both should be law by September 1. One measure calls for a sweeping reorganization of the executive branch to strengthen its hand in dealing with long range energy problems. The other creates a \$20 billion research and development program to move the United States toward self-sufficiency in energy.

N74-21625# Committee on Interstate and Foreign Commerce
(U. S. House)

**TRANSPORTATION CONTROLS UNDER THE CLEAN AIR
ACT**

Washington GPO Sep. 1973 64 p refs Presented to Comm. on Interstate and Foreign Com., 93d Congr., 1st Sess., Sep. 1973

(GPO-20-345) Avail: Subcomm. on Public Health and Environment

A Congressional investigation of the provisions of the Clean Air Act and the effects on various parts of the economy, especially the transportation aspects, was conducted. The subjects discussed are: (1) Environmental Protection Agency, (2) reaction to proposed transportation control strategies, (3) relationship between new car emission standards and transportation control requirements, and (5) energy implications of transportation controls. The majority of the information consists of testimony from selected persons with expertise in the environmental protection subjects. P.N.F.

(AD-768232-1-GA) CONSEQUENCES OF THE
PRESENT POLICY OF DEMAND ACCOMMODATION. Doctor,
R. D. (Rand Corp., Santa Monica, Calif. (USA)). Apr 1973.
20p. (P-5016). NTIS \$3.60.

Potential technological solutions to the problems caused by continuing rapid growth of electricity demand are examined. It finds these technological solutions by themselves are inadequate. It concludes that there is a clear need to consider and evaluate policies that attack the root of the problem - the rapidly growing demand for electricity. Combined with other policies to stretch the fuel resource base, a policy of slowing the growth of California's electricity consumption could provide us with sufficient time for the resolution of current controversies and the development of new environmentally compatible supply technologies. (GRA)

**PUBLIC POLICY TOWARD ENVIRONMENT 1973: A
REVIEW AND APPRAISAL.** Nuclear and Other Energy. Seaborg, G. T. (Univ. of California, Berkeley); Ecom, J. L.; Nelson, E. L. Ann. N. Y. Acad. Sci.; 216: 79-88 (18 May 1973).

The applications of nuclear and other non-conventional sources of energy would lessen the dependence on imported fuels, conserve depletable oil and gas reserves; and ease adverse environmental impacts, especially in air pollution. The alternatives will have to prove a significant capacity over a long period to justify expenditures for R&D and other costs of the new technology. Environmental impacts must be reasonable. Geothermal, solar, wind, and tidal power are alternatives, but when the safety and environmental issues are satisfactorily resolved, nuclear power has the best prospect of meeting all these performance criteria. It is the only source capable of making a significant contribution in the near term. (MCW)

REGULATORY ALTERNATIVES AND SUPPLY OF CLEAN FUELS. Reed, J. L. (Dept. of the Interior, Washington, DC). Chem. Eng. Progr.; 69: No. 11, 72-78(Nov 1973).

The option of whether to encourage domestic production of residual fuel oil or rely on imports, becomes an important issue involving refinery construction. The unique characteristics of residual fuel oil are discussed. Residual fuel oil production by a crude oil replacement program has been encouraged. The result of this program would be that new and expanded refineries would obtain a more balanced refinery configuration than present facilities that are concerned with producing light products. Increased domestic production of residual fuel oil would promote economic development, enhance national security, and benefit the environment. The effect on the petrochemical feedstocks arising from the drawback plan is analyzed. Other potential occurrences such as the manufacture of SNG from oil feedstocks are considered. (MCW)

FEDERAL ENERGY ADMINISTRATION. Hearings Before a Subcommittee of the Committee on Government Operations, House of Representatives, Ninety-Third Congress, First Session, on H. R. 11793. To Reorganize and Consolidate Certain Functions of the Federal Government in a New Federal Energy Administration in Order to Promote More Efficient Management of Such Functions, December 10 and 11, 1973. Washington, DC; Committee on Government Operations (1973). 367p. GPO.

The hearings were conducted to hear testimony to establish a Federal Energy Administration to provide an administrative mechanism for the emergency conservation measures and related emergency actions that will be authorized under separate legislation. The roles of the proposed FEA, ERDA, NEC, and DENR are clarified. Statements are presented from personnel in many energy-related fields. (MCW)

N74-16689# Committee on Interior and Insular Affairs (U. S. Senate).

FEDERAL ENERGY ORGANIZATION: A STAFF ANALYSIS. Washington GPO 1973 66 p refs Presented to Comm. on Interior and Insular Affairs. 93d Congr., 1st Sess. 5 Mar. 1973. Avail: Comm. on Interior and Insular Affairs

A Congressional staff analysis was prepared to provide information on the significance of energy organization and the present organization structure for handling energy matters. A history of the Federal Energy Organization is provided and the functions in various areas of resources management are defined. The deficiencies in existing Federal Energy Organizations are analyzed. A tabulation of the Federal Energy Agencies is provided. Summaries of proposed Federal reorganization for energy are developed. P.N.F.

N74-16688# Committee on Interior and Insular Affairs (U. S. Senate).

LEGISLATIVE AUTHORITY OF FEDERAL AGENCIES WITH RESPECT TO FUELS AND ENERGY: A STAFF ANALYSIS. Washington GPO 1973 240 p refs Presented to Comm. on Interior and Insular Affairs. 93d Congr., 1st Sess., 1973. Avail: SOD HC \$1.65

A Congressional committee report on the authority of Federal agencies with respect to fuels and energy emergency management is presented. It is stated that more than forty Federal departments, agencies, and regulatory commissions affect energy matters. The reorganization and restructuring of these Federal energy activities is a principal concern of the Committee involved in the energy study. A staff analysis is developed to show the statutory authority of Federal agencies and the implementation of that authority in the energy field. The staff analysis is based on a questionnaire which requested the following information: (1) goals and objectives of the energy and (2) a summary of their respective roles within the overall body of Federal fuels and energy policy formulation and implementation. The term Energy Policy is defined as all basic legal authority which authorized programs or policies designed to assist, to promote, to regulate, or to impose constraints on the range of alternatives which local, State, Federal, or private decision makers may consider in their effort to meet existing and future energy demands.

Author

ENERGY CRISIS AND INTERNATIONAL POLICY. Sakisaka, M. (Japan Energy Economic Research Inst., Tokyo). At. Jap.; 17: No. 4, Suppl., 47-52(Apr 1973).

From 8th annual conference of the Japan Atomic Industrial Forum; Tokyo, Japan (7 Mar 1973).

Significance of the energy crisis in view of future prospect is first elucidated: then several uncertain factors in future oil supply are mentioned, and finally the necessity of international cooperation to cope with the difficulties is pointed out. The world energy consumption, centered in petroleum, is ever increasing because of population increase and rising living standard. In this situation, the utilization of nuclear energy plays an important role. The factors causing the uncertain supply of petroleum are the change taking place in supply mechanism, energy shortage in the U. S., possible international friction over the petroleum supply, and oil conservation policy taken by oil producing countries. To cope with the world problems of energy crisis, the international cooperation, one among oil consuming nations and the other between consuming and producing nations, is essential, in which full consideration must be given to those developing countries. (GA)

1973

1973

N74-12681* Auburn Univ., Ala.
NATIONAL ENERGY POLICY

In its TERRASTAR: Terrest. Appl. of Solar Technol. and Res.
Sep. 1973 12 p refs [For availability see N74-12674-03-34]
CSCL 05A

The efforts of the U.S. government to cope with the national energy crisis are discussed. The provisions of several legislative actions to implement the actions for energy conservation are examined. Immediate conservation measures and the long range planning for energy resources are reported.

Author

N74-15687# Committee on Interior and Insular Affairs (U. S. Senate).
THE PRESIDENT'S ENERGY MESSAGE AND S. 1670
Washington GPO 1973 889 p refs Hearing pursuant to S. Res. 45 before Comm. on Interior and Insular Affairs, 93d Congr., 1st Sess., 1 May 1973
Avail: Comm. on Interior and Insular Affairs

The message of the President of the United States concerning energy resources which was delivered to the Committee on Interior and Insular Affairs on 1 May, 1973 is presented. The subjects discussed are: (1) the National energy policy. (2) developing domestic energy resources. (3) importing fuels to meet demands, (4) conserving energy. (5) research and development projects for energy sources, and (6) international cooperation. The message prepared the development of legislation to authorize the President to allocate energy and fuels when he determines and declares that extraordinary shortages or dislocations in the distribution of energy and fuels exist or are imminent. The legislation provides for the delegation of authority to the Secretary of the interior to carry out the provisions of the bill.

Author

ON THE LIMITS OF ENERGY RELEASE AND IMPLICATIONS FOR PRESENT POLICY.

C. Barus.
J. Engineering for Industry, v.95, Ser.B, no.,
Feb.1973, p.383-390.

ENERGY REORGANIZATION ACT OF 1973. : Hearings Before a Subcommittee of the Committee on Government Operations, House of Representatives, Ninety-Third Congress, First Session, on H. R. 11510. To Reorganize and Consolidate Certain Functions of the Federal Government in a New Energy Research and Development Administration and in a Nuclear Energy Commission in Order to Promote More Efficient Management of Such Functions, November 27, 28, and 29, 1973. Washington, DC: Committees on Government Operations and Science (1973). 426p. GPO.

The hearings were conducted and the advantages of the creation of an independent Energy Research and Development Administration (ERDA) are listed. Statements are included from nuclear scientists, geologists, economists, fossil fuel industrialists, environmentalists, government relations personnel, electric utilities personnel, space scientists, Friends of the Earth, Sierra Club, researchers, and members of the committee. (MCW)

1973

TITLE: Energy Reorganization Act of 1973
CORPORATE AUTHOR: U.S. House of Representatives,
Committee on Government Operations
PUBLICATION DESCRIPTION: Report No. 93-707, 73 p.
PUBLICATION DATE: 1973
ABSTRACT: The Committee on Government Operations reviewed HR 11510, the Energy Reorganization Act of 1973, and reports favorably on it with an amendment. It recommends passage of the bill as amended. This report includes the following: summary and purpose of the bill; need for the legislation; background of the bill and hearings on it; administrative organization and missions of the Energy Research and Development Administration (ERDA); functions transferred to ERDA; ERDA's authority; functions of the Nuclear Energy Commission (NEC); estimated savings and costs of the Energy Act applicable to functions transferred from the AEC and to functions remaining in NEC; and section-by-section analysis of the bill. Appendices contain a list of sponsors of the bill; personnel provisions of HR 11510; organizational charts; and the text of the bill as reported by the committee with amendments. Additional views from two Congressmen are also included. (NPG)

1973

TITLE: A British View of World Energy Policy
AUTHOR: Adam, R.W.
CORPORATE AUTHOR: British Petroleum Co. Ltd.
ADDRESS: London, England
PUBLICATION DESCRIPTION: Part of National Energy Priorities - A National Energy Policy for the Future. Proceedings of 1973 Rocky Mountain Petroleum Economics Institute, p. 145-150
PUBLICATION DATE: 1973
ABSTRACT: The limit in the world capability to meet oil demands is stressed. Consequently, a greater share of the energy needs must be supplied by nuclear power. Various economic considerations are explored in the present-day oil situation. An atmosphere of international cooperation in energy matters is urgently needed. (JMC)
AVAILABILITY: Ms. Lyne Roll, Industrial Economics Div., Denver Research Institute, University of Denver, Denver, CO 80202 (\$7.00 prepaid for entire proceedings)

TITLE: What Constitutes an Energy Policy?
AUTHOR: Aspinall, W.N.
CORPORATE AUTHOR: U.S. House of Representatives
PUBLICATION DESCRIPTION: Part of National Energy Priorities - A National Energy Policy for the Future. Proceedings of the 1973 Rocky Mountain Petroleum Economics Institute, p. 1-9
PUBLICATION DATE: 1973
ABSTRACT: Past energy policies in the U.S. were based on the assumption of cheap and abundant energy. This should be replaced with a philosophy of energy conservation. Certain specific actions should be taken immediately while waiting for a government-wide energy policy to be formulated, the House of Representatives could set up an overall energy committee. (JMC)
AVAILABILITY: Ms. Lyne Roll, Industrial Economics Div., Denver Research Institute, University of Denver, Denver, CO 80201 (\$7.00 prepaid for entire proceedings)

74V10441 1973 ISS 00 IJ123.U535 1973 333.7 LC-73-601489

HOW THE FEDERAL GOVERNMENT PARTICIPATES IN ACTIVITIES AFFECTING THE ENERGY RESOURCES OF THE UNITED STATES. REPORT TO THE CONGRESS, BY THE COMPTROLLER GENERAL OF THE UNITED STATES.

UNITED STATES. GENERAL ACCOUNTING OFFICE.

WASHINGTON 42 P. 27 CM.

COVER TITLE. "B-178205." PUBLICATION DATE STAMPED ON T.P.

LC POWER RESOURCES -- UNITED STATES.

ADDED N#US##

MAIN-CORP TRACE-TITL* CATLG BY-LC 71

TITLE: Presidential Energy Statements
CORPORATE AUTHOR: U.S. Senate. Committee on Interior and Insular Affairs
ADDRESS: Washington, DC
PUBLICATION DESCRIPTION: Committee Print Serial No. 93-23 (92-58). Printed at the request of Henry M. Jackson, Chairman, pursuant to S.Res. 45, A National Fuels and Energy Policy Study, 108 p.
PUBLICATION DATE: 1973
ABSTRACT: The President has addressed himself to a broad range of energy issues in a series of messages, statements and speeches, particularly in the last few months. In order to make these Presidential documents more readily available, I have directed that his principal statements on energy be compiled and published for the use of Senators participating in the National Fuels and Energy Policy Study. (Sen. H.M. Jackson, from Memorandum of the Chairman)
AVAILABILITY: GPO (\$1.05)

TITLE: Energy Emergency Act
CORPORATE AUTHOR: U.S. House of Representatives. Committee on Interstate and Foreign Commerce
PUBLICATION DESCRIPTION: Report No. 93-710, 97 p.
PUBLICATION DATE: 1973, December 10
ABSTRACT: This is a committee report recommending several changes to H.R. 1450, submitted December 10, 1973. The changes are listed, together with the reasons for each. The bill authorizes controls on end-uses of petroleum products, calls for proposals for mandatory energy conservation measures, contains provisions to increase domestic oil production and directs steps to be taken to make more effective use of our nation's coal resources. Narrowly defined and limited variances from air quality requirements, together with measures to relax procedural requirements have been permitted. Included is a provision creating a Federal Energy Administration. (JMC)

1973

1973

The U.S. Energy Crisis: The Multinational Oil Corporations and Their Relationship to U.S. Foreign Policy in the Middle East
Army War Coll., Carlisle Barracks, Pa.

Examines the activities of multinational oil corporations, the existing energy crisis, and the interactions relative to changes in the U.S. energy policies and the behavior of the multinationals. Feb. 1973. 56 pp. PC \$3/MF \$1.45
order AD-760-868

N74-16862# Committee on Interior and Insular Affairs (U. S. Senate).

ENERGY EMERGENCY LEGISLATION. PART 1
Washington: GPO, 1973. 364 p. refs. Hearing on S. 2589 before Comm. on Interior and Insular Affairs. 93d Cong., 1st Sess., 8 Nov. 1973.

Avail: SOD HC \$2.35

A Congressional hearing concerning emergency energy legislation was conducted. The purpose of the legislation was as follows: (1) to declare by congressional action a nationwide energy emergency, (2) to authorize the president to immediately undertake specific actions to conserve scarce fuels and increase supply, (3) to initiate the development of local, state, national, and international contingency plans, and (4) to assure the continuation of vital public services.
P.N.F.

ENERGY: ACTION AND REACTION.

Chemical Engineering, May 28, 1973, p.56,58,60.

President Nixon's energy message finally emerges bringing few surprises and evoking both praise and criticism. Oil and gas policy draw the most attention.

Title: An Assessment and Analysis of the Energy

Emergency

AUTHOR: Cooper, B.

CORPORATE AUTHOR: U.S. Senate, Committee on Interior and Insular Affairs

ADDRESS: Washington, DC

PUBLICATION DESCRIPTION: Committee Print Serial No. 93-25 (92-60), A Staff Analysis prepared at the request of Henry M. Jackson, Chairman, pursuant to S.Res.45, A National Fuels and Energy Policy Study, 16 p.

PUBLICATION DATE: 1973

ABSTRACT: Because of the inadequacy of available data within the government, the Committee was compelled to compile on its own initiative an assessment of the energy emergency and an analysis of its causes and impact. In the interest of informing the public about the magnitude of the problem we are facing the results of that effort are set forth in this document.---The study describes both the background and the conditions which led to current energy supply shortages and the urgent need for action to minimize the impacts of these shortages. It concludes that we must initiate the rationing of gasoline at the earliest possible date if we are to avoid shortages far in excess of any previously projected. From the study of the material contained in this document, there are three inescapable conclusions: First, the information required to determine and assess the extent of impending energy shortages in most cases has been available in the public domain, but no agency of the Federal government has compiled or made any competent analysis of such data. Second, there has been no adequate analysis of the anticipated social and economic impacts of projected fuel shortages. Third, the extent of the shortages and the threat they pose to the economy and to national security exceed by far any savings resulting from measures taken to date by the executive branch. (Sen. H.M. Jackson, from Resolutions of the Chairman)

US ENERGY POLICY AFTER THE PRESIDENT'S MESSAGE. Corrigan, R. (National Journal, Washington, DC). **Energy Policy** 1: No. 1, 66-70(Jun 1973).

Some of the problems coming with increasing oil imports are described. The President's program is outlined (oil production, allocation, natural gas, coal, nuclear, energy research, energy conservation) and prospects are discussed. A brief account is given of political organization and attitudes in the White House.

1973

The policy effects analysis method: A system dynamics simulation study of the defense fuel supply system RAND Corp., Santa Monica, Calif. STEINLE, J. D. NOV. 1973. 18 PAGES. RMFS. Presented at Conf. of the Operations Res. Soc. of Am., San Diego, Calif., 12-14 Nov. 1973. p-5129
 AVAIL- THIS HC \$4.00
 *COMPUTERIZED SIMULATION, *JET ENGINE FUELS, *MILITARY AIRCRAFT, *PROCUREMENT POLICY
 CRUDE OIL, INTERNATIONAL RELATIONS C34 F74-22598 1

Toward a National Policy on Energy Resources and Mineral Plant Foods.
 Samuel P. Ellison, Jr.
 Texas Univ., Austin. Bureau of Economic Geology. 1973. 138p
 PB-230 248/7WE PC\$4.75/MF\$1.45

A report is made on the first of the university conferences concerning what our national policy should be on oil, gas, coal, nuclear, geothermal, solar sources on energy resources and on all varieties of mineral plant foods. Directions on what policy should be taken on educational endeavor are included.

- 179 Energy in the USA after the President's messages...
 Likely effects on supply and demand
 Stephen L. McDonald
- 187 Energy in the USA after the President's messages...
 Changes in investment and balance of payments
 William E. Simon

Energy Policy, v.1, no.3, Dec.1973.

THE PRESIDENTS ENERGY MESSAGE AND SCIENCE POLICY.
 W.H. Donnelly.
 Public Science Newsletter, v.4, no.5, May 1973,
 p.2-9.

1973

TOWARD A NATIONAL ENERGY POLICY. Friedlander, G. D. IEEE (Inst. Elec. Electron. Eng.), Spectrum; 10: No. 6, 36-43 (Jun 1973).

As early as 1952, a Presidential commission realized the need for a government-inspired and -coordinated energy policy, but today, with our energy demands spiraling, our internal resources seriously depleted, and our economy weakened by an adverse balance-of-trade deficit that precludes indefinitely increasing fuel purchases from abroad, what energy policies exist are promulgated by 61 difference agencies. A tabulation of the federal agencies that presently administer energy policies and programs is shown. The task is monumental for coordination and augmentation of the federal operating programs and reorganization for energy implementation is proposed. (JCW)

TOWARD AN ENERGY ETHIC. Gustavson, M. R. (Univ. of California, Livermore). EOS, Trans., Amer. Geophys. Union; 54: No. 7, 676-681 (Jul 1973).

Explicit differences in viewpoints that exist regarding the energy crisis are discussed. There are disagreements as to the nature or even the existence of the problem. There are differences in the types of consequences that are of primary concern. There is no commonly accepted and suitable framework within which to resolve many of the fundamental issues. The review gives some insight into the variety of primary concerns that motivate those engaged in the energy dialog, another barrier to productive discussion that often goes unrecognized.

TITLE: Energy's Impact on Foreign Policy

AUTHOR: Darstadter, J.
CORPORATE AUTHOR: Resources for the Future, Inc.
ADDRESS: 1755 Massachusetts Ave. NW, Washington, DC 20036

PUBLICATION DESCRIPTION: Consulting Engineer, 40(3), 186-192

PUBLICATION DATE: 1973, March
ABSTRACT: Discussed in this article are: trends in U.S. energy consumption, the transition of the U.S. from a net exporter to a net importer of energy resources; the geographic origin of the imports; future energy supply sources; alternatives for the future; balance of payments; and national security. (RFE)

1973

TITLE: National Energy Priorities - A National Energy Policy for the Future
CORPORATE AUTHOR: University of Denver
ADDRESS: Denver, CO 80210

PUBLICATION DESCRIPTION: Proceedings of the 1973 Rocky Mountain Petroleum Economics Institute held June 17 to 20 at Sun Valley, Idaho, 153 p.

PUBLICATION DATE: 1973

SPONSOR: Rocky Mountain Oil and Gas Association
ABSTRACT: The 1973 Rocky Mountain Petroleum Economics Institute was concerned with the details of national energy policy and methods to meet U.S. energy needs. The major emphasis was on petroleum and the problems in this country, but some attention was also devoted to other energy sources and to the worldwide problems. Eleven papers were presented. (JMC)

AVAILABILITY: Ms. Lynne Poll, Industrial Economics Div., Denver Research Institute, University of Denver, Denver, CO 80210 (\$7.00 prepaid)

ENERGY POLICY FROM THE FEDERAL STANDPOINT. David, E. E. (Science Advisor to the President, Washington, DC). Chem. Eng. Progr.; 69: No. 6, 22-26 (Jun 1973).

The energy policy is a major concern of the Office of Science and Technology. Seven departments of the government involved in research and development in energy are the Atomic Energy Commission, Interior Department, the Environmental Protection Agency, the Commerce Department through the Bureau of Standards, the National Science Foundation, NASA, and the Department of Transportation. A recognized policy involves technological, economic, social, legal, political, environmental, and moral problems. The President's Science and Technology Message to Congress in 1973 is analyzed. Near, medium, and long term challenges are outlined. (MCW)

ADMINISTRATION'S PLANT SITING AND ENERGY POLICIES. DiBona, C. J. Pub. Util. Forum.; 91: No. 13, 21-26 (21 Jun 1973).

The proposed Electric Facilities Siting Act of 1973 as recommended in President Nixon's message on the environment on Feb. 17, 1973 and introduced in the 93rd Congress is discussed. Legislative provisions deal with long-range planning, organization of certifying agencies (state and federal), certification procedures, and actual certification authority. Questions and answers on the President's Energy Message to Congress are presented. (JCW)

74

1973

TITLE: Import Conditions and Balance of Payment

Implications

AUTHOR: Lipton, M.

CORPORATE AUTHOR: Levy, W.J., Consultants Corp.

PUBLICATION DESCRIPTION: Part of National Energy

Priorities - A National Energy Policy for the

Future, proceedings of the 1973 Rocky

Mountain Petroleum Economics Institute, p.

35-59

PUBLICATION DATE: 1973

ABSTRACT: Most studies of future energy

requirements assume large increases in

petroleum imports. Presently proposed

policies to encourage domestic production

will not be effective because of this import

uncertainty. A different incentive method is

proposed. (JMC)

AVAILABILITY: Ms. Lynne Roll, Industrial

Economics Div., Denver Research Institute,

University of Denver, Denver, CO 80210

(\$7.00 prepaid for entire proceedings)

ENERGY: A STRATEGY OF DIVERSITY.

E.E. David, Jr.

Tech. Rev., June 1973, p.26-31.

The stakes in the energy crisis and in the longer range future of us US energy supplies are high indeed. But a coalition of forces and policies - not monolithic technological attack - is the only appropriate response.

ENERGY AND THE FUTURE: RESEARCH PRIORITIES AND NATIONAL POLICY.

A.L. Hammond.

Science, v.179, no.4069, Jan.12,1973, p.164-166.

The energy problems facing the United States are only partially amenable to technological solutions. Not every new energy conversion device nor every exotic energy source needs to be developed. More significant, in the long run, will be new attitudes and policies that take into account finite resources and equitable distribution of the costs of producing energy.

S-423

ENERGY AND NATURAL RESOURCES.

(Statement by the President announcing a series of additional actions to deal with the nation's energy problem. June 29,1973.)

Weekly Compilation of Presidential Documents, v.9, no.26, July 2,1973, p.867-874.

ENERGY AND FOREIGN POLICY. Hearings Before the Committee on Foreign Relations, United States Senate, Ninety-Third Congress, First Session on the Implications of the Current Energy Problem for United States Foreign Policy, May 30 and 31, 1973. Washington, DC: Committee on Foreign Relations (1974). 240p. GPO.

A general survey of the energy problem and its implication for American foreign policy was provided at the committee hearings by well-qualified specialists from within and outside the Government. The Arab oil-producing states were thinking about the leverage of their oil wealth as a weapon in their dispute with Israel and in their related dealings with the great powers even at this time in May, 1973. The energy requirement of the United States in relation to the Persian Gulf was the theme of the hearings. (MCW)

75

1973

TITLE: President's Statement on Energy, Summary

Catline - Fact Sheet

AUTHOR: Nixon, R.M.

CORPORATE AUTHOR: Executive Office of the

President

ADDRESS: White House, Washington, DC

PUBLICATION DESCRIPTION: Executive order, 2 p.;

Statement by the President, 8 p.;

Catline and Fact Sheet, 12 p.

PUBLICATION DATE: 1973, June 29

ABSTRACT: The complete text of the president's

statement is given. Topics covered include,

background, recent significant developments,

organization of Federal energy and natural

resource activities, energy research and

development, and energy conservation.

Included are proposals to organize the Energy

Policy Office, the Department of Energy and

Natural Resources, and the Energy Research

and Development Administration. (JMC)

1973

N74-17669# Committee on Interior and Insular Affairs (U. S. Senate)
A REVIEW OF ENERGY POLICY ACTIVITIES OF THE 92D CONGRESS

1973 87 p refs Presented to Comm. on Interior and Insular Affairs, 93d Congr., 1st Sess., 30 Dec. 1972 Prepared by Library of Congr.

Avail: Comm. on Interior and Insular Affairs

The provision of an adequate supply of all needed forms of energy at reasonable and stable prices, with incentive for their continued adequate provision, without degradation of the environment or jeopardy to the national security, and with minimum waste is discussed. Three basic areas are discussed: the legislation that was enacted; the legislation that was proposed but not enacted; and the hearings that were held by the various committees and subcommittees of the Congress. In addition, reports concerning energy that were issued are included. Author

New Scientist, v.60, no.870, Nov.1,1973, p.322-333.

The energy equations

Realities of the energy crisis Chauncey Starr

Energy analysis in policy making Dr Malcolm Slesser

Battle for an EEC energy policy Dr John Thomas

322

328

330

1973

TITLE: The States and the Energy Crisis - A Catalogue of State Action
CORPORATE AUTHOR: Southern Interstate Nuclear Board
ADDRESS: Suite 104, 7 Dunwoody Park, Atlanta, GA 30341

PUBLICATION DESCRIPTION: 505 p.

PUBLICATION DATE: 1973

ABSTRACT: The energy crisis activities being undertaken at executive, legislative and administrative levels of state governments in the United States are compiled in this report. Executive orders, proposed and enacted bills, and other official documents are included, with brief summaries of each state's activities preceding the documents. (MPC)

National Journal Reports, v.5, no.41, Oct.13,1973, p.1505-1550.

- ENERGY 1: CLEAR US POLICY REMAINS ELUSIVE GOAL AS WORLD AND DOMESTIC DEMAND FOR FUEL RISES SHARPLY. p.1505-
- ENERGY 2: IMMEDIATE PROSPECTS. p.1508-
- ENERGY 3: GOVERNMENT REORGANIZATION. p.1517-
- ENERGY 4: RESEARCH MANAGEMENT. p.1527-
- ENERGY 5: RESEARCH AND DEVELOPMENT. p.1531-
- ENERGY 6: WORLDWIDE OIL POLITICS. p.1539-

ENERGY POLICY INTERACTIONS IN THE UNITED STATES. Smernoff, B. J. (Hudson Inst., Inc., NY). Energy Policy, 1: No. 2, 136-153(Sep 1973).

The U. S. policies in the economic, national security, research and development, and environmental areas were formulated prior to the 1973 energy crisis. The establishment of an energy policy that is consistent with other existing national policies will be difficult, when the inconsistencies already existing are considered. Heavily funded breeder reactor development exemplifies the type of inconsistency existing. It is suggested that a reasonable energy policy involves nuclear fission playing a minor role, clean-burning fossil fuels decreasing in importance, and geothermal or solar energy sources becoming dominant. (68 references) (MCM)

N74-14884# RAND Corp., Santa Monica, Calif.
ENERGY POLICY RESEARCH AND THE STATE OF FLORIDA
William E. Mooz Aug. 1973 17 p Sponsored by NSF and the State of Calif
(P-5078) Avail: NTIS HC \$3.00

A discussion of state energy problems and the research required to support the selection of policies designed to solve them. The example chosen is the State of Florida, in which future energy demands may be in conflict with its unique environment, and the basis for the discussion is Rand's past and present energy work for the National Science Foundation and the State of California.

Author

ENERGY CRISIS: PRESIDENT SPRINTS TO CATCH UP WITH
WITH EVENTS. R. Gillette.
Science, v.182, Nov.23,1973, p.807-808.

74N71306 72/00/00 669 PAGES UNCLASSIFIED DOCUMENT
FEDERAL LEASING AND DISPOSAL POLICIES
COMMITTEE ON INTERIOR AND INSULAR AFFAIRS (U. S. SENATE). AVAIL
COMM. ON INTERIOR AND INSULAR AFFAIRS
WASHINGTON GPO HEARING BEFCRE COMM. ON INTERIOR AND INSULAR
AFFAIRS. 92ND CONGR., 2ND SESS., 15 JUN. 1972
/*GOVERNMENTS/*LAND MANAGEMENT/*POLICIES/*RESOURCES MANAGEMENT/
COAL/ ENERGY REQUIREMENTS/ GEOTHERMAL RESOURCES/ NATURAL GAS/ SHALE
OIL

74N72734 72/00/00 186 PAGES UNCLASSIFIED DOCUMENT
A REVIEW OF ENERGY POLICY ACTIVITY OF THE 92D CONGRESS, FIRST
SESSION
A/PERRY, H.: B/BEARD, D.: C/BROWN, H. A/(COMP.): B/(COMP.):
C/(COMP.)
COMMITTEE ON INTERIOR AND INSULAR AFFAIRS (U. S. SENATE): LIBRARY
OF CONGRESS, WASHINGTON, D.C. AVAIL COMM. ON INTERIOR AND INSULAR
AFFAIRS
WASHINGTON GPO PREPARED BY LIBRARY OF CONGR.
PRESENTED TO COMM. ON INTERIOR AND INSULAR AFFAIRS, 92D CONGR., 2D
SESS., 30 DEC. 1971
/*CONGRESS/*DECISION MAKING/*ENERGY POLICY/ ENERGY SOURCES/
MANAGEMENT PLANNING/ PROBLEM SOLVING

73N72915 DOS-PUBL-8662 72/08/00 6 PAGES UNCLASSIFIED DOCUMENT
THE INTERNATIONAL IMPLICATIONS OF THE ENERGY SITUATION GENERAL
FOREIGN POLICY SERIES 265
A/IRWIN, J. N., II
STATE DEPT., WASHINGTON, D.C. (OFFICE OF MEDIA SERVICES.)
/*ENERGY SOURCES/*INTERNATIONAL COOPERATION/ ENERGY REQUIREMENTS/
PRODUCTION ENGINEERING

FRESH WHITE HOUSE MOVES TO COPE WITH ENERGY CRISIS.
U.S. News & World Rept., July 9, 1973, p.21,22.

A new "energy czar"...a new conservation drive.
They're the latest White House actions to relieve
a summer gasoline problem that is touch and go.

ENERGY SHORTAGE - THE PRESIDENT'S BLUEPRINT FOR
MEETING THE NATION'S NEEDS.

U.S. News & World Report, Apr.30,1972, p.7276.

WHITE HOUSE ENERGY POLICY: WHO HAS THE POWER?
Science, v.179, Mar.23,1973, p.1211-1212.

PRESIDENT NIXON TAKES A FIRM STAND ON ENERGY.
Nature, v.244, July 6,1973, p.4.

PERSPECTIVES ON POWER AND POLICY. SIMPSON,
J. W. Pub. Util. Fortn.; 91: No. 7, 34-39(29 Mar 1973).

The shift to the electrical economy must be the core of a national energy policy, but the formulation of a meaningful policy may not come in time to avert a real energy crisis. The entire electric energy industry must act to develop strategy to meet the future energy demands. Substitutes must be found for gas and oil when possible. Coal is one substitute, electrical power from a nuclear energy base is another. (auth)

FACING THE ENERGY CHALLENGE. Warren, F. M.
(Edison Electric Inst., New York). Pub. Util. Fortn.; No. 7, 31-33(29 Mar 1973).

In view of the many dimensions of the energy challenge, it is better to have the widespread interest in what is being done to avert a true energy crisis than have the lack of attention that existed when electricity and other forms of energy were taken for granted. Co-ordination of nationwide energy policies is urgently needed. Confusion and contradictions must be eliminated. (JCW)

ENERGY SECURITY - NEW DIMENSION FOR US POLICY.
Brig. Gen. G. A. Lincoln, USA (Ret).
Air Force Mag., Nov.1973, p.49-55.

N74-19617# Committee on Commerce (U. S. Senate).
COUNCIL ON ENERGY POLICY
Washington GPO 1973 225 p refs Hearings on S. 70 and
S. 419 before Comm. on Com., 93d Congr., 1st Sess., 7-8 Feb.
1973
Avail: Comm. on Com.
Hearings on the establishment of a national energy resources
advisory board are presented. Measures to coordinate energy
policies and improve management of energy resources are
outlined.
S.K.W.

CN-129,866

1972
SOME IMPLICATIONS OF POLICIES TO SLOW THE
GROWTH OF ELECTRICITY DEMAND IN CALIFORNIA.
Kent P. Anderson. (Prepared for the Calif. State
Assembly). (This study represents one portion of
the research in R-1116-NSF/CSA, "CALIFORNIA'S
ELECTRICITY QUANDARY: III: SLOWING THE GROWTH
RATE", dtd Sept. 1972). Dec.1972. 71p.

Rand Corp.

R-990-NSF/CSA

Rand Corp.

R-1116-NSF/CSA
NSF 01-44 (For R-1116-NSF/CSA see CN-129,866)

Energy Plants

Electricity

Earth - Resources

L-8-29-73

N74-18803 Sierra Club, Washington, D.C. Energy Policy
Committee.

MAN VERSUS HIS INSTITUTIONS

Keith Roberts /n Mitre Corp. Symp. on Energy, Resources and
the Environment. Vol. 3 14 Apr. 1972 p 83-109 ref (For
availability see N74-18598 09-34)

The goals of a rational energy policy encompass: (1) limitation
of total energy consumption to those amounts necessary for a
quality of life compatible with the carrying capacity of the
environment; (2) use of a combination of energy sources for
maximum efficiency; (3) minimization of ecological disruption,
aesthetic harm, or damage to human and animal health; (4)
public policy making procedures to achieve above goals; and
(5) elimination of undue special interest propaganda based on
one-sided facts.
G.G.

N-129,690 92d Congress, 2d Session
Committee on Interior and Print 92-7
and Insular Affairs

COMPILATION OF FEDERAL LAWS RELATING TO FUEL AND ENERGY
RESOURCES. Prepared for Use of the Comm. on Interior
& Insular Affairs of the U.S. House of Representatives.
Dec.1972.

N74-18596 Harvard Univ., Cambridge, Mass.
MECHANISMS FOR ACHIEVING CLEANER POWER.
PRICES, REGULATIONS
Marc Roberts /n Mitre Corp. Symp. on Energy, Resources and
the Environment. Vol. 2 13 Apr. 1972 p 136-187 (For availability
see N74-18591 09-34)

The following three policy mechanisms to achieve cleaner
power are appraised: prices, regulation, and direct public provision.
It is shown that the resource-environmental-energy linkup at the
current level of pollution is due to multiplicative interaction of
the amount of output per capita, the number of people, and the
amount of pollution per unit output. The need for shifting some
of the distribution impact of the projected financing burden from
the poor population is emphasized.
G.G.

CN-129,810

TITLE: The Energy Crisis: Some Policy

Alternatives

AUTHOR: Abrahamson, D.E.; Otway, R.J. (Ed.)
CORPORATE AUTHOR: University of Minnesota, Center
for Studies of the Physical Environment
PUBLICATION DESCRIPTION: LA-8895-NS, transcript
of colloquia held at Los Alamos Scientific
Laboratory, December 18, 1971, 13 p.

LABORATION DATE: 1972, February
ABSTRACT: The author outlines some problems
associated with formulating a national fuels
and energy policy. Included in the discussion
are: the problems of reliable fuel supplies,
which are closely related to foreign policy
and foreign trade; the relationship of energy
intensiveness and unemployment; the
decreasing efficiency of energy utilization;
the question of whether large amounts of
energy are needed to clean up the
environment; and the need for an energy
policy to determine what energy uses are
necessary and how energy can be supplied
without further environmental deterioration.
(NPG)

PETROCHEMICALS AND OUR ENERGY POLICIES.

W.C. Brown, Hercules, Ins.

Chem. Eng. Prog., v.68, no.4, Apr.1972, p.33-36.

1972

CN-129,867

N74-16680# RAND Corp., Santa Monica, Calif.
CALIFORNIA'S ELECTRICITY QUANDARY. 3: SLOWING
THE GROWTH RATE
R. D. Doctor, K. P. Anderson, M. B. Berman, S. H. Dole, M. J.
Hammer, P. T. McClure, and C. B. Smith Sep. 1972 158 p
refs
(Grant NSF GI-44)
(R-1116-NSF/CSA) Avail: NTIS HC \$10.00

Results are presented of one part of a broad study effort on the underlying cause of the conflict between energy and the environment-the rapid increase in demand for energy in all its forms-and on the implications of this conflict for governmental policymaking. The objectives are: (1) to examine the need for new state policies that would slow the growth of electricity demand; (2) to estimate the potential effectiveness of policies designed to slow the growth rate; and (3) to evaluate the potentially important side effects of slowed electricity growth.
Author

TOP PRIORITY: DRAWING UP AN ENERGY POLICY.
Business Week, Dec.16,1972, p.64,65.

Fuel forecasts: high costs, low supply. Congress
demands an over-all plan.

N74-16653 Stanford Research Inst., Menlo Park, Calif. Energy
and Resources Economics.
GOVERNMENT, POLICIES, NATIONAL OBJECTIVES, AND
THE ENERGY INDUSTRIES
Sherman H. Clark /in Denver Univ. Balancing Supply and Demand
for Energy in the US 1972 p 9-27 refs (For availability see
N74-16651 07-34)

The requirements for the development of a national policy on energy sources and utilization are discussed. The economic factors which influence the availability of natural gas and petroleum are analyzed. The impact of energy availability on the national goals of economic growth and employment is examined. The most immediate issues to be resolved are identified as oil and gas pricing and the security of the supply of these resources. Tables of data are included to show: (1) free world oil production from 1970 to 1990, (2) energy demands and oil imports from oil producing and exporting countries, (3) the importance of offshore oil imports, and (4) U.S. energy consumption patterns for 1968.
Author

1972

N74-18585 Massachusetts Inst. of Tech., Cambridge.
COMPUTER SIMULATION OF WORLD DYNAMICS AND
IMPLICATIONS FOR POLICY DECISIONS
Jay Forrester /in Mitre Corp. Symp. on Energy, Resources and
the Environment, Vol. 1 12 Apr. 1972 p 29-48 (For availability
see N74-18582 09-34)

It is stipulated that energy and resource policies are coupled to social issues. The effects of technology in social breakdown are stressed and it is suggested that energy demands should not be fully met for the long term good of society. Instead, the growth rate in the use of energy and resources should be gradually reduced so that demands no longer rise. The inevitable slowing of growth requires adjustment of our system policies on ethics, rightness, and humanitarianism to new concepts of human equality.
G.G.

N74-18593 California Univ., Livermore. Lawrence Livermore
Lab.
AN ENERGY ETHIC
Marvin R. Gustavson /in Mitre Corp. Symp. on Energy, Resources
and the Environment, Vol. 2 13 Apr. 1972 p 28-67 (For
availability see N74-18591 09-34)

The development of a consensual energy ethic is projected that leads to public agreement as to what is fair in respect to the various aspects of source development. Key issues are: Source development -- particularly of fossil fuel; energy use -- as affected by education, advertising, and legislation; (3) nationalism -- in the national security sense as seen by a citizen of a consuming nation; (4) pollution -- as a negative factor in the quality of life; (5) Federal funding -- as an element of public support; and (6) fusion reactors -- as an example of a possible technological key to abundant energy.
G.G.

ENERGY DILEMMA. J.R. Schlesinger.
Oak Ridge Nat. Lab. Rev.; 5: no.4, 8-13(1972).

Relations of public policy with energy production are discussed. The ability of the American society to deal with the energy dilemma is considered. Projections of future energy requirements are reviewed to bring in focus the problems faced by society.

1972

1971

N74-18592 Virginia Univ., Charlottesville.
NATIONAL ENERGY POLICIES

Fred Singer /in Mittle Corp. Symp. on Energy Resources and the Environment, Vol. 2 13 Apr. 1972 p 2-27 (For availability see N74-18591 09-34)

It is stressed that socioeconomic considerations require the development of abundant and low cost energy in a national policy. The energy should be environmental clean and reasonable self-sufficient to insure long term national security. Public policies and regulations and a lead agency are required to assume these responsibilities and to fund the various sources of energy exploration. G.G.

N74-16666# Committee on Interior and Insular Affairs (U. S. Senate).

THE EVOLUTION AND DYNAMICS OF NATIONAL GOALS IN THE UNITED STATES

Franklin P. Huddle Washington GPO 1971 66 p refs Presented to Comm. on Interior and Insular Affairs. 92d Congr., 1st Sess., 16 Aug. 1971 Prepared by Library of Congr. Avail: Comm. on Interior and Insular Affairs

A Congressional hearing was conducted to examine the evolution and dynamics of the National Goals in the U.S. The study reviews the history of national goal formation beginning with the Preamble to the Constitution of the United States. The process and specifics of national goal formation during several administrations are described. The background information provided by the study is considered useful in identifying the role of the energy policy in the implementation of national goals. The subjects contained in the study are: (1) historical evolution of the goals of the U.S., (2) maturation of early constitutional goals, (3) succession of national goals in the past half-century, (4) the interaction of science and technology with national goals, and (5) recent attempts to chart new goals for America. P.N.F.

N74-16667# Committee on Interior and Insular Affairs (U. S. Senate).
A REVIEW OF ENERGY ISSUES AND THE 91ST CONGRESS
Washington GPO 29 Jan. 1971 41 p refs Presented to Comm. on Interior and Insular Affairs. 92d Congr., 1st Sess., 15 Dec. 1970 Prepared by Library of Congr. Avail: Comm. on Interior and Insular Affairs
A review of the energy crisis issues considered by the U.S. Congress was conducted. The purpose of the review is to examine the interrelationships between energy supply, the environment, resource conservation, economic growth, and the attainment of important national goals. The policy issues in the energy field involve the following: (1) oil imports, (2) trans-Alaska pipeline, (3) outer continental shelf, (4) natural gas supply, (5) shortages and movement toward an overall energy policy, (6) electric power generation and transmission, and (7) nuclear energy development and environmental effects. P.N.F.

TITLE: Toward a National Power Policy: Reconciling Needs for Energy and Environmental Protection

AUTHOR: Fabricant, M.; Hallan, R.H.
CORPORATE AUTHOR: New York City Environmental Protection Administration

PUBLICATION DESCRIPTION: Report submitted to the Mayor's Interdepartmental Committee on Public Utilities, New York City, 300 p.

PUBLICATION DATE: 1971, April
ABSTRACT: This study analyzes the social costs of power generation and argues the formation of an energy policy "that will provide for essential needs while adequately protecting the environment and public health, and making the best use of limited resources." The report has three main sections: Health Hazards and Other Environmental Problems posed by Electric Power; Major Methods for Dealing Directly with Environmental Damage Associated with Electric Power and Assessment of Industry, as well as governmental, efforts; and Utility and Regulatory Practices which Hinder Environmental Planning. (HPO)

74N72613 E/C.7/2/ADD.2 71/01/11 20 PAGES UNCLASSIFIED DOCUMENT

NATURAL RESOURCES DEVELOPMENT AND POLICIES, INCLUDING ENVIRONMENTAL CONSIDERATIONS

UNITED NATIONS ECONOMIC AND SOCIAL COUNCIL. AVAIL. NTIS
/ENERGY CONSUMPTION/ENVIRONMENT POLLUTION/POLICIES/PRODUCTION
ENGINEERING/ EARTH RESOURCES/ ELECTRIC POWER/ ENERGY TECHNOLOGY

73AV29031 1971 ISS 0C JUL23.447 333.E2 LC-72-600685

GOALS AND OBJECTIVES OF FEDERAL AGENCIES IN FUELS AND ENERGY;
PREPARED AT THE REQUEST OF HENRY M. JACKSON, CHAIRMAN, PURSUANT TO S.
RES. 45, A NATIONAL FUELS AND ENERGY POLICY STUDY.
UNITED STATES. CONGRESS. SENATE. COMMITTEE ON INTERIOR AND INSULAR
AFFAIRS.

U.S. GOVT. PRINT. OFF., WASHINGTON, III, 131 P. ILLUS. 24 CM.
AT HEAD OF TITLE 92D CONGRESS, 1ST SESSION. COMMITTEE PRINT.
SERIAL NO. 92-9."

LC POWER RESOURCES -- UNITED STATES. FUEL -- UNITED STATES.

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MAIN-CORP. TRACE-TITL# CAILG BY-LC

1971

1970

N71-36181# Committee on Interior and Insular Affairs (U. S.
Senate).

NATIONAL FUELS AND ENERGY POLICY

Washington GPO 1971 133 p refs Hearing on S. Res. 45
before Comm. on Interior and Insular Affairs. 92d Congr.
1st Sess., 25 Feb. 1971

Avail: Comm. on Interior and Insular Affairs

Congressional testimony concerning a study of the nation's
energy resources and a review of the body of law and policy
which influence the energy situation is presented. Examples of
problems throughout the energy system which indicate the need
for such an investigation are presented. Statements of law
makers from various states are included to define the scope of
the problem.
P.N.F.

N71-30165# Committee on Interior and Insular Affairs (U.S.
Senate).

FUELS AND ENERGY

Washington GPO 1970 262 p refs Hearings on S. 4092
before Comm. on Interior and Insular Affairs. 91st Congr., 2d Sess.,
10 11 Sep. 1970

Avail: Subcomm. on Minerals, Water, and Fuels

Public hearings on September 10-11, 1970 before the
Senate Subcommittee on Minerals, Materials, and Fuels regarding
a bill to establish a Commission on Fuels and Energy are reported.
The purpose of such a commission is to recommend programs and
policies to insure the U.S. requirements for low cost energy are
met and to reconcile environmental quality requirements with
future energy needs.
A.C.R.

**N71-29471# Committee on Public Works (U.S. Senate).
SOME ENVIRONMENTAL IMPLICATIONS OF NATIONAL
FUELS POLICIES**

Washington GPO 1970 74 p refs Presented by Comm. on
Public Works. 91st Congr., 2d Sess., Dec. 1970

Avail: SOD \$0.30

An objective analysis of the factors relevant to the development
of fuels and energy policies compatible with environmental quality
requirements is presented as a staff report to the Chairman of the
Committee on Interior and Insular Affairs. Based on the expected
population growth, the energy and fuel requirements are projected
to the year 2000. Techniques and processes for pollution control
are discussed, and the expenditures for pollution research are
summarized for FY 1969, 1970, and 1971.
F.O.S.

D. RESEARCH AND DEVELOPMENT

1974

The Futurist, v.VIII, no.1, Feb.1974.

1974

Energy Research: Scientists Seek to Ease the Pinch
By Richard W. Roberts 19

The energy crisis is intensifying the search by scientists for answers in a wide variety of fields. The Director of the National Bureau of Standards, a U.S. Government laboratory with a staff of 3,500, tells how research in materials, housing design, low temperature physics, and other areas can contribute significantly to easing the energy shortage.

1974

PROJECT INDEPENDENCE: WHAT, IF, AND WHEN?
N.R. Iamartino.
Chem. Engineering, v.81, no.6, Mar.18, 1974,
p.46-47, 50.

There is little chance that by 1980 the U.S. can be independent of foreign energy sources. However, the billions of dollars now being spent for research and development could bring self-sufficiency by 1985.

1974

KEY ISSUES IN SETTING PRIORITIES FOR NEW ENERGY TECHNOLOGY RESEARCH AND DEVELOPMENT.

G.C. Werth.

IEEE Trans. Nuc. Sci., v.NS-21, no.1, Feb.1974,
p.23-32.

The U.S. must rapidly proceed with energy research and development. It remains, however, an open question as to what criteria should be used to judge R&D projects or more broadly stated, what strategy or rationale is appropriate for energy R&D. This article presents the elements of such a strategy.

N74-18605# Committee on Aeronautical and Space Sciences
(U. S. Senate).
ENERGY-RELATED RESEARCH AND DEVELOPMENT
Washington GPO Mar. 1974 95 p refs Presented to Comm.
on Aeron. and Space Sci., 93d Congr., 2nd Sess., Mar. 1974
Prepared by NASA, Washington, D. C.
Avail: SOD HC \$1.00

Technology developed for space and aeronautics has useful applications to energy needs and problems on earth. The specific research and development projects include work in solar energy utilization, including wind energy systems; energy conversion, transmission and storage; transportation systems; and energy and environment conservation. Programs in aeronautics and space which are directly relevant to energy include remote sensing applied to energy resources, fuel conservation in aeronautics, energy conversion and storage, and space and nuclear technology. The transfer to the private sector of aeronautical and space technology applicable to energy needs is another way in which significant contributions are made in energy research and development.

Author

1974

(UCRL-51511) RATIONALE FOR SETTING PRIORITIES FOR NEW ENERGY TECHNOLOGY RESEARCH AND DEVELOPMENT. Rubin, B.; Wheeler, S.; Ramsey, W.; Werth, G. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 4 Jan 1974. Contract W-7405-eng-48. 60p. Dep. NTIS \$5.00.

A strategy for employing new technologies to meet United States energy shortages by 1985, including a set of ground rules for choosing among different technologies, is presented. Twenty-five technology areas are indicated, each of which meets the ground rules and is potentially capable of providing at least 0.5×10^{11} Btu/yr by 1985. Source energy prices and 1985 energy production quantities are estimated. Total R&D costs are estimated to be \$5.7 billion; total production plant capital costs would be about \$73 billion. Relative values of different technologies are compared on the basis of city-gate energy prices. Development of these technologies would approximately double the commercially-available fossil fuel reserves, assuming an energy price increase (in 1973 dollars) of about 30% over 1973 prices. Non-fossil reserves also would be greatly increased. Addition of the energy supplies produced by these new technologies to the supplies derived through conventional means could lead to self-sufficiency in energy by the mid-1980's. (auth)

1973

(WASH-1281-15) MULTIDIRECTIONAL RESEARCH. Subpanel Report XV Used in Preparing the AEC Chairman's Report to the President. Creutz, E. C. (USAEC, Washington, D. C.). 27 Oct 1973. 254p. Dep. NTIS \$15.75.

Multidirectional research greatly increases the chances that existing ideas can be successfully developed. At the same time it provides a sound base for new directions when they are needed. That is, research will frequently suggest quite new lines of development not contemplated when the program was first defined. If the technologies now visualized should prove inadequate, then research, if properly encouraged and supported early enough, will lead to modified approaches with increased probability of success. The scope of multidirectional research required in support of the energy research and development program is thus very wide in disciplines and interdisciplinary areas. It is organized into five subprograms: (1) materials research; (2) chemical, physical, and engineering aspects of energy production, utilization, and waste processing; (3) biological generation of fuels, treatment of effluents, the environment, and resources; (4) plasmas, major untapped sources, and new concepts; and energy economics, social response to energy availability and regulation, and mathematical techniques. The funding of each subprogram for the fiscal years 1975-1979 is outlined, with the total for the 5-year period being \$250/350 million. (LMT)

85

(TID-26528, pp 221-242) ENERGY RESEARCH AND DEVELOPMENT INSTITUTIONAL PATTERNS. Chapter V. Paine, T. O. (General Electric Co., New York). Dec 1973.

In report of the Cornell Workshops on the major issues of a national energy research and development program, September 14.-October 17, 1973.

It is stated that a highly goal-oriented organization and management is needed to facilitate assessment, coordination, and direction of the many complex activities that will be carried out by diverse groups in many locations. The responsibilities of the federal government; cabinet-level department of energy and natural resources; agency for energy R&D; technology assessment carried out by high government; industry; cooperative industrywide R&D; private corporate R&D; and assessment of institutional capability are described. The objectives of the USA energy R&D entail environmental and safety standards; synthetic oil and gas from coal and oil shale; synthetic nuclear fuel from uranium and thorium; energy conservation and conversion; and R&D on equipment, systems, and processes. (MCW)

(TID-26528, pp 1-73) OVERVIEW OF AN INTEGRATED NATIONAL ENERGY RESEARCH AND DEVELOPMENT PROGRAM. Chapter I. Auer, P. L. (Cornell Univ., Ithaca, NY). Dec 1973.

In report of the Cornell Workshops on the major issues of a national energy research and development program, September 14, 1973-October 17, 1973.

An attempt was made to structure a well-balanced effort aimed at supporting a near-term objective while maintaining both mid-term and long-term objects. The current energy crisis creates another thought that suggests that a maximum emergency measure should be adopted to reduce anticipated shortfalls in natural gas and oil, and create a synthetic fuel industry. These are not in the realm of R&D. It is deemed possible to start design and construction of first-generation plants immediately. By 1985, ten to eighteen oil shale extraction plants each with 100,000 bbls of oil per day capacity requiring \$500 to \$600 million capital per plant could be a reality. Also eighteen to twenty-six high-Btu gas plants each with 250 million cu feet per day capacity requiring some \$500 million capital per plant, mine included, and another approximate \$100 million if deep mining is necessary, could be in operation. Legislation would be required that would allow construction of these plants as demonstration plants. The general categories applying to R and D programs are discussed in the general sections of conservation, fossil fuel option, nuclear option, and renewable resources. (MCW)

U.S. Federal Power Commission. Task Force on Energy Distribution Research. ENERGY DISTRIBUTION RESEARCH; RESEARCH AND DEVELOPMENT PROGRAMS FOR 1975-1994. Recommendations of the Task Force on Energy Distribution Research, Technical Advisory Committee on Research and Development, consultants to the Task Force Supported by the National Science Foundation, Washington, D.C. Chairman of the Task Force: Robert A. Bell. Program Director for the consultants: James Nicol. Cambridge, Mass., Arthur D. Little, 1973. 1 vol. (various pagings)

PHYSICAL RESEARCH: A THREE-TIERED STRATEGY IN SUPPORT OF ENERGY R AND D. Zucker, A. Oak Ridge Nat. Lab, Rev.: 6; No. 3, 7-10 (Fall 1973).

A three-tiered strategy in support of energy R & D is outlined that involves providing crucially needed data for nearly complete technologies; providing the expected but not at all certain discovered research underpinning of the entire project. A two-phase model is cited of a near- and long-term model such as reducing the dependence on imported oil and gas by 1985 to 10 or 15% of total energy consumption, and a long-term goal to advance the energy base through a variety of technological developments after 1985. In the near-term, coal could be substituted for oil or gas in power generation plants and the development of coal liquefaction and gasification technologies need be advanced. The long-term strategy involves uranium or thorium breeder reactors, thermonuclear fusion reactors, geothermal energy, solar energy, energy storage batteries, large-scale hydrogen production, and superconducting transmission lines. (MCW)

CENTER FOR ENERGY STUDIES. This report covers the past accomplishments and present capabilities of the Kansas State University College of Engineering in the power and energy related research. This report contains abstracts of technical articles, reports, theses and dissertations written by the faculty, staff, and students. The abstracts are classified into five sections: General and systems analysis, solar and wind energies, magnetohydrodynamics, nuclear energy, environmental effects and energy resources from wastes, and fuel production. Each section is subdivided into four subsections: Journal Articles, Presented Papers, Reports, and Theses and Dissertations. The order within each subsection is arranged chronologically.

Pen, L. T. *Kan State Univ, Inst Syst Des Optimization*. Rep 8 30 Jul 1973, 34 p.

(TID-26528) REPORT OF THE CORNELL WORKSHOPS ON THE MAJOR ISSUES OF A NATIONAL ENERGY RESEARCH AND DEVELOPMENT PROGRAM. September 14, 1973-October 17, 1973. (Cornell Univ., Ithaca, N. Y. (USA). Coll. of Engineering). Dec 1973. 263p. TIC. The purpose of the workshop was to develop information that would provide independent assessment of the stated options for the ultimate development of an integrated energy R&D program, for the nation. After a presentation of an overview of an integrated national energy R&D program, a summary is given of the four workshop areas on fossil fuel option, the short-term nuclear option, the advanced nuclear power, and energy R&D institutional patterns. Separate abstracts were prepared for the five papers. (MCW)

(WASH-1281-13) TRANSPORTATION SYSTEMS. Subpanel Report XIII Used in Preparing the AEC Chairman's Report to the President. Petrick, E. N. (USAEC, Washington, D. C.). 27 Oct 1973. 314p. Dep. NTIS \$18.75.

The transportation energy R and D goal is as follows: to develop the technology necessary to reduce transportation demand for crude oil and other fuels by improved efficiency, new designs with higher efficiencies, and utilization of alternative fuels. Specifically, in pursuit of this goal, the proposed transportation energy R and D program will reduce transportation dependence on crude oil by 22% in the year 1985, 55% in the year 2000, and up to 100% after the year 2000 from the levels of consumption that otherwise would be experienced without the proposed program. The transportation sector is grouped into four subprograms—autos/trucks, air, rail/bus, and ships—for purposes of this program development. The contribution of each to the overall goal, along with a summary of the transportation energy R and D program funding proposal, is presented. (auth)

1973

N74-11788# Committee on Science and Astronautics (U. S. House). **ENERGY RESEARCH AND DEVELOPMENT: AN OVERVIEW OF OUR NATIONAL EFFORT**
Washington GPO 1973 51 p. Hearing before Comm. on Sci. and Astronaut., 93d Congr., 1st Sess., No. 10, 15 May 1973
Avail: Subcomm. on Energy

A Congressional hearing was conducted to discuss the research and development efforts directed toward providing sources of energy. The funds available for research and development by government and private agencies are presented. The various alternate sources of energy are described to show the level of effort for each source. The long range priorities which involve the development of new energy sources and the conservation of energy are analyzed. Examples of alternate energy sources are included to show specific techniques for energy conversion.
P.M.F.

N74-10892# Committee on Science and Astronautics (U. S. House). **ENERGY RESEARCH AND DEVELOPMENT AND SPACE TECHNOLOGY**
Washington GPO 1973 574 p. refs. Hearings before Subcomm. on Space Sci. and Appl. and Subcomm. on Energy, 93d Congr., 1st Sess., No. 9, 7, 22, and 24 May 1973
Avail: Comm. on Sci. and Astronaut.

A Congressional hearing on energy research and development was conducted. The circumstances leading to the present energy crisis are discussed. The various methods for obtaining energy from solar, geothermal, wind, and tidal sources are defined. The projects which are expected to produce new methods for obtaining energy are analyzed.
Author

NEW NSF/RANN PROGRAM ON ENERGY.
Environmental Sci & Tech., v.7, no.13, Dec.1973,
p.1102-1103.

Formed in September, its Advanced Energy Research & Technology Division is looking at technology that may have a payoff in the mid 1980's.

18 OUR R&D CHALLENGE FOR NATIONAL ENERGY POLICY

Raymond L. Bieplinghoff

The scope of the R&D task is broader than any of us realized until recently: we cannot go with piecemeal results—we must shape through R&D a complete system picture, from source to user.

Astronautics & Aeronautics, v.11, no.8, Aug.1973.

(NP-19787) PROGRAM PLAN FOR THE NATIONAL CENTER FOR ENERGY MANAGEMENT AND POWER. Denton, J. C. (Pennsylvania Univ., Philadelphia (USA). National Center for Energy Management and Power). 15 Jan 1978. 65p.
The task of the National Center for Energy Management and Power, established in May 1971, is to educate "problem-solving" individuals who can successfully manage the Nation's energy and power problems to enable the society to pursue its objectives. The planning of educational and research programs at the Center for achieving this goal in close cooperation with industry and the government is discussed. (LCL)

N73-30338# Bureau of Mines, Bartlesville, Okla. Energy Research Center. **N74-20619# BUREAU OF MINES ENERGY PROGRAM 1972**
Bill Unwin and John D. Spencer. 1973 116 p
(BM-IC-8612) Avail: NTIS HC \$8.00

Technologies for improving the production and utilization of petroleum, natural gas, and coal were investigated. Topics included are: oil recovery from tar sands, energy relationships, environmental activities, coal storage, preparation and transportation, and in situ processing. The investigations of clean fluid fuels from coal, gas purification, reservoir properties, fly-ash utilization, and coal mine health and safety are also reported.
T.M.R.

N74-19606# Joint Committee on Atomic Energy (U. S. Congress).

**ATOMIC ENERGY COMMISSION 1 DECEMBER 1973
REPORT ON ENERGY RESEARCH AND DEVELOPMENT**

Washington GPO 1974 783 p refs Hearing before Joint Comm. on Atomic Energy. 93d Congr., 1st Sess., 11 Dec. 1973

Avail: SOD HC S5 20

Congressional reports on future energy research and development programs are presented. Policies to regain and maintain national energy self-sufficiency are outlined: (1) the conservation of energy by decreasing consumption and increasing the technical efficiency of conversion processes; (2) increase the domestic production of oil and natural gas; (3) increase the use of coal; (4) expand the production of nuclear energy; and (5) promote the use of alternate energy sources such as hydro, geothermal, and solar.

S.K.W.

1973

(ORNL-EIS-73-65) **ENERGY RESEARCH AND DEVELOPMENT. A Selected Reading List.** Gauthier, M. P., Hubert, E. E.; Norwood, G. A. (eds.). (Oak Ridge National Lab., Tenn. (USA)). Nov 1973. Contract W-7405-eng-267. 287p. 14p. NTIS \$14.00.

A selected listing of 1,219 publications is assembled for the identification of promising areas for energy research and development. The document is designed to assist the layman. The focus of the reading list was a need to gain a perspective on what has already been done in energy research and development. The perspective was required to support the development of a report to the President from the Chairman of the AEC on long-range energy research and development needs and policy as requested in the President's June 29, 1973, statement on Energy and National Resources. The bibliography emphasizes general publications on energy sources, electric power, generation, energy uses, and references on energy supply and demand studies. An appendix includes an author index, a simple title index, and a permuted index on titles. (MCW)

(ORNL-EIS-73-65)(Rev. 1) **ENERGY RESEARCH AND DEVELOPMENT. A Selected Reading List.** Gauthier, M. P.; Hubert, E. E.; Norwood, G. A. (eds.). (Oak Ridge National Lab., Tenn. (USA)). Nov 1973. 99p. Dep. NTIS \$7.60.

A listing of 1205 selected readings was assembled to aid policymakers in the identification of areas for energy research and development. A perspective was necessary on the state of energy research and development to support the development of a report to the President from the Chairman of the AEC on long-range energy research and development needs and policy. The bibliography includes general publications on energy sources, electric power, generation, energy uses, and Congressional publications related to energy. The use of the permuted index on titles is included. An author index is given. (MCW)

R AND D PRIORITIES AND FUNDING: THE YEAR OF DECISION. Papamarcos, J. (ed.). Power Eng.; 77: No. 9, 52-59 (Sep 1973).

The research and development for energy use was reviewed with existing technology and mid-term and long-term planning. It was shown that the energy crisis or crunch can be improved and that the technology can be developed for practically unlimited clean energy in the future. Proper planning and timely decisions are urgently needed. None of the priorities are accepted without argument. Proved and estimated reserves of all fuels, present and projected demands for all fuels, environmental restraints on production of fuels, present and future environmental restraints on siting and operating various types of power plants, present and future environmental restraints on transmission and distribution of electric power, and present and future environmental restraints on high capacity pipelines for transmission of gaseous fuels are all subjects of controversy, not to mention the allotting of the funds appropriated for researches. An Energy Policy Council, an Energy R&D Agency, and a National Energy R&D Planning Body are proposed. (MCW)

TITLE: Fiscal Year 1973 Awards by Program -

Subprogram
COMPACT: AUTHOR: National Science Foundation,
Research Applications Directorate, Research
Applied to National Needs, Intergovernmental
Science

ADDRESS: Washington, DC 20550

PUBLICATION DESCRIPTION: 68 p. report

PUBLICATION DATE: 1973, October 28

ABSTRACT: This report consists of a computer print-out of research projects funded by the National Science Foundation through June 30, 1973. The information includes the name of the principal investigator, the institution performing the research, the title of the project, the date the project started, the effective date of the funding, and the amount of the funding. (Pp6)

AVAILABILITY: National Science Foundation, RA
Document Center, Room 601, 1800 G Street NE,
Washington, DC 20550

RA

1973

1973

ENERGY RESEARCH AND DEVELOPMENT. Ninety-Third Congress, First Session, December 1, 1973. Washington, DC: Joint Committee on Atomic Energy (1973). 63p. GPO.

The Committee on Interior and Insular Affairs issued the report on a bill to establish a national program for research, development and demonstration in fuels and energy and for the coordination and financial supplementation of Federal energy research and development, to establish development corporations to demonstrate technologies for shale oil development, advanced power cycle development, geothermal steam development, and coal liquefaction and gasification development, to authorize and direct the Secretary of the Interior to make mineral resources of the public lands available for the development corporations. Comments from governmental agencies on the bill are published. (MCW)

N74-14692# Committee on Commerce (U. S. Senate). ENERGY RESEARCH AND DEVELOPMENT. 2 Washington GPO 1973 166 p. Hearing on S. 357 before Comm. on Com. 93d Cong., 1st Sess., 1 Mar. 1973

Avail: Comm. on Com.

A Congressional hearing was conducted to establish a Federal power research and development program to increase efficiencies of electric energy production and utilization, reduce environmental impacts, develop new sources of clean energy, and reduce the use of fossil fuels. The various features of the energy bill are: (1) establishment of a Federal Power Research and Development Board, (2) establishment of a trust fund, (3) authorization of a research program, and (4) definition of penalties for failure to comply with the provisions of the act. The report consists of testimony by witnesses concerning the utilization of energy and new energy sources. Author

74V10421 1973 ISS 00 JUL53-U46 333.7 LC-73-601367
ENERGY RESEARCH AND DEVELOPMENT. REPORT, NINETY-SECOND CONGRESS,
SECOND SESSION. DECEMBER, 1972.
UNITED STATES. CONGRESS. HOUSE. COMMITTEE ON SCIENCE AND
ASTRONAUTICS. TASK FORCE ON ENERGY.
U.S. GOVT. PRINT. OFF.: WASHINGTON, XIV, 404 P. 24 CM.
AT HEAD OF TITLE COMMITTEE PRINT. "SERIAL EE." INCLUDES
BIBLIOGRAPHICAL REFERENCES.
LC POWER RESOURCES -- RESEARCH -- UNITED STATES.
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1973

1973

N74-12668# Committee on Science and Astronautics (U. S. House).
UNIVERSITY ENERGY RESEARCH CENTERS
Washington GPO 1973 52 p. refs. Hearing on H.R. 8348 and H.R. 9133 before Comm. on Sci. and Astronaut., 93d Cong., 1st Sess., No. 11, 23 Jul. 1973

Avail: NTIS. Avail: Subcomm. on Energy

A Congressional hearing is presented concerning the enactment of bills for enlisting the aid of academic researchers in carrying out energy R and D programs. Previous bills and past efforts are cited. The relationship between national laboratories to universities and the relation of either or both to private industry and the Federal Government, and to mission oriented projects associated with power engineering research are discussed. The designation of certain leading institutions and universities in certain fields is also considered. T.M.R.

CN-129,708

N74-12687# Committee on Science and Astronautics (U. S. House).
THE FEDERAL GOVERNMENT AND ENERGY: R AND D HISTORICAL BACKGROUND
Washington GPO Mar. 1973 111 p. refs. Presented to Comm. on Sci. and Astronaut., 93d Cong., 1st Sess., 20 Mar. 1973 Prepared by Library of Congr.

Avail: Subcomm. on Energy

Energy source R and D is traced for the Navy, the National Bureau of Standards, Federal Power Commission, Tennessee Valley Authority, Atomic Energy Commission, National Science Foundation, National Aeronautics and Space Administration, and Advisory boards and committees. A historical look at aviation technology is given along with research in the Dept. of Interior including geological surveys for the Bureau of Mines, and Offices of Oil, Gas, and Coal. T.M.R.

63

1973

An Assessment of New Options in Energy Research and Development.

Office of Science and Technology, Washington, D.C. Energy Advisory Panel. Nov 73, 297p AET-9 PB-229 725/WE PCS6.75/MF51.45

In response to a request in the President's energy message of June 1971, a study was carried out of options for national energy research and development. A framework was developed to intercompare the benefits of disparate R and D activities and, within that framework eleven technological areas were evaluated: resource extraction, solar energy, geothermal energy, coal utilization, advanced cycles for power generation, alternate breeder reactors, fusion, hydrogen and other synthetic fuels, electrical transmission, transportation and urban and residential energy use. R and D programs were recommended in each of these areas.

TITLE: Energy Research and Development - Problems and Prospects

AUTHOR: Perry, R.
CORPORATE AUTHOR: Resources for the Future Inc.
ADDRESS: 1755 Massachusetts Ave. NE, Washington, DC 20036

PUBLICATION DESCRIPTION: Committee Print Serial No. 93-21 (92-56). Prepared at the request of Henry M. Jackson, Chairman, pursuant to S.Res.45, A National Goals and Energy Policy Study, 175 p.
PUBLICATION DATE: 1973
SPONSOR: U.S. Senate, Committee on Interior and Insular Affairs

ABSTRACT: This report reviews existing energy research and development programs and the options available through greater commitment of our national resources and technological capabilities in the years ahead. In describing the goals which might be achieved at different levels of funding, it makes clear how such can be done by accelerating energy research and development efforts. (Sen. H.M. Jackson, from Memorandum of the Chairman)
AVAILABILITY: GPO (91.09)

ENERGY: A STRATEGY OF DIVERSITY.

E.E. David, Jr., Gould, Inc.
Technology Review, v.75, no.7, June 1973, p.26-31.

The stakes in the 'energy crisis' and in the longer-range future of U.S. energy supplies are high indeed. A coalition of forces and policies - not a monolithic technological attack - is the only appropriate response.

1973

(ORNL-EB-73-63(Vol. 1)) INVENTORY OF CURRENT ENERGY RESEARCH AND DEVELOPMENT. Caton, G. M.; Chilton, J. M.; Huffstetler, J. K.; Kline, B. W.; Michelson, D. C.; Guthrie, M. P.; Uffinkson, G. U. Oak Ridge National Lab., Tenn. (USA). Dec 1973. Contract W-7405-eng-26. 632p. DTIC NTIS \$33.75.

The document is a result of a survey of current research on energy problems and presents an overview of the research and development being done on most aspects of energy sources, electric power, energy uses and health and ecological effects. The inventory consists of data on 1) 4807 research projects related to energy problems; 2) indices that include information on research facilities, sponsoring agencies, principal investigators, locations where research performed, and permuted title index of research projects; and 3) funding summary tables. A description of the questionnaire package sent to research investigators and organizations is given. This volume, Vol. 1, contains descriptions of 1078 projects on energy sources and the first 1513 projects on electric power. (See also Vols. 2 and 3) (MCW)

(ORNL-EB-73-63(Vol.2)) INVENTORY OF CURRENT ENERGY RESEARCH AND DEVELOPMENT. Caton, G. M.; Chilton, J. M.; Huffstetler, J. K.; Kline, B. W.; Michelson, D. C.; Guthrie, M. P.; Uffinkson, G. U. Oak Ridge National Lab., Tenn. (USA). Dec 1973. Contract W-7405-eng-26. 574p. DTIC NTIS \$30.75.

This volume, Vol. II, contains descriptions of the remaining 1147 projects on electric power, 728 projects on energy uses and energy (general), and 441 projects on health and ecological effects. (See also Vols. 1 and 3). (MCW)

(ORNL-EB-73-63(Vol.3)) INVENTORY OF CURRENT ENERGY RESEARCH AND DEVELOPMENT. III. Indices. Caton, G. M.; Chilton, J. M.; Huffstetler, J. K.; Kline, B. W.; Michelson, D. C.; Guthrie, M. P.; Uffinkson, G. U. Oak Ridge National Lab., Tenn. (USA). Dec 1973. Contract W-7405-eng-26. 405p. DTIC NTIS \$22.25.

This volume, Vol. III, contains the indices to Vols. 1 and 2, namely: Research Facility Index; Sponsor Index; Investigator Index; Location Index; and Permuted Title Index. (MCW)

ENERGY R & D: SLICING THE PROMISED PIE.

R. Gillette.
Science, v.181, no.4106, Sept.23,1973, p.1233-1234.

1973

1973

TITLE: Incentives for Energy R & D

AUTHOR: White, P.C.

CORPORATE AUTHOR: Standard Oil Co. (Indiana)

ADDRESS: Chicago, IL

PUBLICATION DESCRIPTION: Part of National Energy

Priorities - A National Energy Policy for the

future, proceedings of the 1973 Rocky

Mountain Petroleum Economics Institute, p.

71-92

PUBLICATION DATE: 1973

ABSTRACT: In the period 1975-1985 the U.S.

deficit of crude oil will be 75 billion

barrels total. Various R & D programs are

suggested to alleviate this shortage. Until

1985, priority should be given to improving

current oil and gas technology. From 1985 to

2000 the emphasis should be on fast breeder

reactors and fuel consumption efficiency.

After 2000 the fields of geothermal, solar,

and fusion power should be well advanced.

(JMC)

AVAILABILITY: Mc. Lyne Holl, Industrial

Economics Div., Denver Research Institute,

University of Denver, Denver, CO 80210

(\$7.00 prepaid for entire proceedings)

1973

**Testimony Before the Subcommittee on Energy of the
Committee on Science and Astronautics, House of
Representatives.**

David C. White.

Massachusetts Inst. of Tech., Cambridge. Energy Lab. 23 Jul

73. 7p NSF-RA/N-73-048

PB-227 885/1WE PCS4.00/MF\$1.45

Based on MIT's past experiences on mission-oriented research programs and extensive interaction with industry in research programs, Prof. White recommended that House Bills H.R. 8348 and H.R. 9133 need modification and amplification to include the following general operational features: (1) Specific ties to mission-oriented agencies such as the proposed ERDA with line item funding for long term core programs of research and special funding for facility development; (2) Special authority to involve industry in R and D programs through both joint funding and cooperative programs to assure rapid reduction of research to practice and effective transfer to the industrial sector; (3) The establishment of a limited number of major research laboratories to supplement the National Laboratories with a clear mission for each; (4) High level government and industry overview committees that will maintain funding and enhance a strong independent management of the research facility.

1973

**TECHNOLOGY, THE ENERGY CRISIS, AND OUR
STANDARD OF LIVING.** Schuman, F. (Atomic Energy Com-
mission, Washington, DC). Mech. Eng., No. 9, 16-23 (Sep
1973).

Cheap energy does most of the work and sustains transporta-
tion systems. The rate of technology investment has continuously
increased during this century until 1965 when, for the first time,
the rate of investment in R & D began to decline and is still de-
clining. There is a definite relationship between standard of
living and productive investment. The impact of technology on the
dollar is discussed. Delays have developed in the nuclear power
field for a variety of technical, mechanical, environmental, and
regulatory reasons that have resulted in a shortage of currently
available energy. Efficiency in energy use in the immediate years
ahead and power generation from fission reactors can assist in the
immediate future. The conservative uses and present know-how
development of fossil fuels are indicated. In the long term, there is
the prospect of nuclear fusion with almost limitless energy pos-
sibilities. To provide a high standard of living in the future, it is
important that the present downward trend in R & D be reversed.
(MCW)

1973

CN-140, 235

(WASH-1281) **NATION'S ENERGY FUTURE.** A Re-
port to Richard M. Nixon, President of the United States. Ray,
D. L. (NSAEC, Washington, D. C.). 1 Dec 1973. 182p. GPO
\$1.95.

This report, developed under the general guidance of the Energy
Policy Office, is in response to the directive of the President on
June 29, 1973, to the Chairman of the Atomic Energy Commission
to review Federal and private energy R and D and to recommend
an integrated program for the Nation. The report is based largely
on the results of: (1) a group of Energy Workshops organized
under the sponsorship of Cornell University, (2) sixteen Technical
Review Panels of 121 Federal employees from 36 Departments and
Agencies assisted by 282 consultants from the private sector, and
(3) an Overview Panel that reviewed the results from the Work-
shops and Technical Panels. A draft of the report was sent to
more than 100 individuals for comment. In addition, Dr. Ray con-
sulted personally with numerous leaders in government, industry,
and the scientific community throughout the period of the Report's
preparation. Specifically, the report recommends: (1) a national
energy R and D program, (2) a five-year, \$10 billion Federal
energy R and D program, and (3) the FY 1976 Federal budget for
energy R and D. The recommended program, based on what is now
known, is both necessary and sufficient to maximize energy R and
D's contribution to the Nation's energy goals, even so, 1985 is
the earliest date by which self-sufficiency can reasonably be ex-
pected. By 1980, the recommended program can reduce oil imports
to half those currently projected, other extraordinary measures
will be required to displace the other half. (DM7)

1972

N74-12688# Committee on Science and Astronautics (U. S. House).
AN INVENTORY OF ENERGY RESEARCH, VOLUME 1
 Washington GPO Mar. 1972 1111 p refs Presented to Comm. on Sci. and Astronaut., 92d Congr., 2d Sess., 20 Feb. 1972. Prepared by ORNL for Task Force on Energy Sponsored by NSF 2 Vol.
 Avail: Subcomm. on Sci., Res., and Develop.
 An inventory of energy research was prepared for the subcommittee on science, research, and development of the U.S. House of Representatives. An overview of the research being conducted on most aspects of energy production and use is provided. The survey was prompted by the concern for the limitation in the sources of energy and the impact of the production and use of energy on the environment. Within fourteen categories of energy sources 4,400 research projects have been identified.
 Author

N74-12689# Committee on Science and Astronautics (U. S. House).
AN INVENTORY OF ENERGY RESEARCH, VOLUME 2
 Washington GPO Mar. 1972 631 p refs Presented to Comm. on Sci. and Astronaut., 92d Congr., 2d Sess., 20 Feb. 1972. Prepared by ORNL for Task Force on Energy Sponsored by NSF 2 Vol.
 Avail: Subcomm. on Sci., Res., and Develop.
 A permitted index of research projects involving energy sources was prepared for the subcommittee on science, research, and development of the U.S. House of Representatives. The index identifies fourteen categories of energy sources and 4,400 research projects within the categories.
 Author

N73-10988# Committee on Science and Astronautics (U. S. House). *also N73-17989#*
ENERGY RESEARCH AND DEVELOPMENT
 Washington GPO 1972 730 p refs Hearings before Comm. on Sci. and Astronaut., 92d Congr., 2d Sess., No. 24, 9-11, 23-25, and 30 May 1972
 Avail: Subcomm. on Sci., Res., and Develop.
 The Subcommittee on Science, Research and Development considers the formulation of a national energy policy facing an estimated fivefold increase in total energy consumption between now and the year 2000. Limited supplies of fossil fuels and hydroelectric power make it necessary to develop other sources of energy, namely, solar power and nuclear power.
 G.G.

1972

N73-10980# Committee on Science and Astronautics (U. S. House).
BRIEFINGS BEFORE THE TASK FORCE ON ENERGY OF THE SUBCOMMITTEE ON SCIENCE, RESEARCH, AND DEVELOPMENT, VOLUME 2
 Washington GPO Mar. 1972 185 p refs Briefings held in Oct. and Nov. 1971 presented to the Comm. on Sci. and Astronaut., 92d Congr., 2d Sess., 21 Mar. 1972
 Avail: Subcomm. on Sci., Res., and Develop.
 The hearings concerning the research and development requirements for future national energy needs are reported. The optimal application of technology for the conservation of minerals, and the enhancement of environmental resources are discussed including: (1) power siting methodology, (2) utilization and disposition of rejected heat, (3) emissions reduction and management, (4) resources exploration and development methodology, and (5) efficient use of energy. Fast breeder reactors, solar arrays, and coal gasification are discussed as energy sources.
 F.O.S.

N73-23969# Committee on Science and Astronautics (U. S. House).
BRIEFINGS BEFORE THE TASK FORCE ON ENERGY, VOLUME 3
 Washington GPO 1972 203 p refs Presented to Comm. on Sci. and Astronaut., 92d Congr., 2d Sess., 15 Aug. 1972
 Avail: Subcomm. on Sci., Res., and Develop.
 The hearings concerning the energy problems of the U.S. are reported. Topics discussed include: environmental protection, better use of natural resources, R and D priorities, water and air pollution, electric power generation, and economic growth.
 For Vol. 2, see N73-10980.
 F.O.S.

N-129,975 92d Congress, 2d Session Serial 92-62a
ENERGY RESEARCH AND DEVELOPMENT. (Hearings before the Committee on Commerce, U.S. Senate - 92d Congress, 2d Session, Amendment No. 364 to S-1684).
 March 15 & 16, 1972

1972

TR-5: Statement of American Petroleum Institute on Energy Research and Development
 CORPORATE AUTHOR: American Petroleum Institute
 PUBLICATION DESCRIPTION: Submitted to the U.S. House of Representatives, Committee on Science and Astronautics, Subcommittee on Science, Research, and Development, 18 p.
 PUBLICATION DATE: 1972, June 15
 ABSTRACT: Basic facts about the energy crisis are reviewed as an introduction to a description of the necessity for energy research and development, and what is being done by the oil and gas industry. Major research projects include exploration techniques, efforts to improve oil recovery rates, deep water producing capability, reservoir stimulation techniques, nuclear stimulation of natural gas reservoirs, arctic oilfield research, and research on synthetic fuels. The government is urged to develop policies that will encourage industry to search for and develop new reserves and to take full advantage of new technology. (NPG)

(NP-19788) **STATUS REPORT, MAY 1972.** (Pennsylvania Univ., Philadelphia (USA). National Center for Energy Management and Power). 1972. 80p.
 The National Center for Energy Management and Power at the University of Pennsylvania was created in May 1971. During this first year of operation much of the Center's resources were spent to establish the program, assemble a faculty that has a strong interest in the area of energy and power management, and provide a basis of understanding so that both faculty and students in the Center may interact. Considerable time was devoted to making the Graduate Group Committee of Energy Management and Power operational. Much effort was required to bring about a different kind of educational program than has existed at the University of Pennsylvania before. The major portion of the Center's resources in the future will be devoted to research activities including interdisciplinary research in ways of increasing the energy supply, methods for modifying energy demand, and means of adjusting the quantitative relations between supply and demand, and small disciplinary research projects. (auth)

(AD-755222) **SUPPORT OF ENERGY PROGRAM PLANNING.** Final Report. Schmidt, R. A. (comp). (Stanford Research Inst., Menlo Park, Calif.). Sep 1972. Contract N00014-72-C-0445. 256p. NTIS.
 Principal energy problem areas of importance to the Department of Defense were identified and possible approaches to advanced research projects directed toward solutions of these problems were suggested to provide partial source material in support of AIDPA's research program planning. Topics regarding sources and application of energy, energy transformation, storage, distribution, and energy utilization were included. For each topic, information was organized according to statement of the problem, state-of-the-art, present activities and organization, implications for the DOD, and recommendations for further studies. (NTIS)

TR-6: Reference Energy Systems and Resource Data for Use in the Assessment of Energy Technologies
 CORPORATE AUTHOR: Associated Universities, Inc.
 ADDRESS: Upton, NY 11973
 PUBLICATION DESCRIPTION: AET-8, 135 p.
 PUBLICATION DATE: 1972, April
 ABSTRACT: The Office of Science and Technology is directing an extensive assessment of new energy technologies in order to identify the most promising set of R&D options. This report presents a reference set of data related to the energy system and a framework for carrying out the assessment. The demand for energy has been projected in twenty-seven end-use categories. Conservative assumptions are made regarding the implementation of new technologies and Reference Energy Systems have been constructed for the years 1969, 1977, 1985, 2000, and 2020. These reference systems show the energy flows through the system, the efficiencies involved, and the consumption of resources. Summaries are presented of energy resources and the first-order environmental impacts of energy use, when applied to the Reference Energy Systems, these data indicate the total resource and environmental impact of energy use in the future. A new energy technology can be evaluated by substituting that technology for appropriate elements of the reference systems and calculating the net change in resource and environmental impacts. This combination of information thus serves as a means of evaluating the potential benefits to be gained by research in various energy technologies. (auth)

CM-129,916 1972
THE COMMISSIONER'S ROLE IN ELECTRIC POWER RESEARCH.
 (Presented at the 1972 Summer Meeting, San Francisco, Cal., July 11, 1972). 1972. 28p.

Institute of Electrical and
 Electronics Engineers
 Institute of Electrical and
 Electronics Engineers, Power
 Engineering Society

**Electricity
 Power sources**

(Paper)
 7ECHO722-9-PWR
 Special Publication
 5
 LB6,476,001
 1-9-6-73

1972

N72-30123# Bureau of Mines, Morgantown, W.Va.
BUREAU OF MINES ENERGY PROGRAM, 1971
John D. Spencer and Bill Linville 1972 109 p refs
(BM-IC-8551) Avail: NTIS HC \$7.50

In 1971 increase emphasis was placed on the production of fluid fuels and chemicals from coal. Advances were achieved in the development of the Synthene and Hydrane gasification processes for producing pipeline gas from coal, and progress was made in research on solid wastes utilization, and on liquid fuels production from coal. Coal mine safety, solid waste disposal and utilization, coal preparation and transport, and fundamental research on coal and related products also continued to be the subject of extensive research. Improved methods for extracting petroleum and natural gas without surface and subsurface pollution are discussed. This research was highlighted by studies of the fracturing systems of reservoir rocks, including subsurface fracture mapping and fracturing techniques to achieve optimum production of oil and gas. Oil recovery by water or gas flooding, by steam injection, on the identification of oil spills, and on means to reduce vehicular exhaust emissions is summarized.

Author

CN-140,005 *Power Sources* 1971
ENERGY RESEARCH NEEDS. Sam H. Schurr. ((Final rept.)
Jan. 15-Aug. 15, 1971). (Prepared for NSF). Oct. 1971.

Resources For The Future, Inc.
Washington, D.C.

(National Science Foundation NSF-RANN-71-2)
National Technical Information PB 207 516
Service (NSF-C-644) 873 pages

Tells where research should be directed to improve understanding of the long-term U.S. energy problem and to create effective policies. In-depth coverage of the forces that influence consumption; the future of domestic mineral fuel reserves; research and development possibilities in energy production and use; the environmental impacts of energy production and utilization activities; and the public policies which significantly affect energy industry operations.

TK2896.I55

1972

ENERGY IN THE 1970'S: A SECOND LOOK. Weirbold, J. F. (Office of Science and Tech., Washington, DC). pp. 1190-1195 of 7th Intersociety Energy Conversion Engineering Conference. Washington: American Chemical Society (1972).

From 7th Intersociety energy conversion engineering conference, San Diego, California, USA (25 Sep 1972). See CONF-720925-Environmental concerns dominated the 1970 energy picture, then turned to the basic economics of energy supply and demand. The National Environmental Policy Act of 1969, with its requirement for environmental impact statements has provided a vehicle for questioning federal actions involving nuclear power plants, other electric power facilities, off-shore oil and gas leases, oil shale development, and other energy technologies. The partnership between government and industry was given high visibility in the President's energy message of June 4, 1972. Each of the three priorities—the liquid metal fast breeder reactor, high-Btu-coal gasification, and sulfur oxide control technologies—is being developed in partnership with industry. New starts were made on several other energy technologies in the FY 73 budget. Additional energy technologies are being considered by a Federal Council for Science and Technology Energy R&D Goals Committee. Industry is also moving to increase its energy R&D efforts through the newly incorporated Electric Power Research Institute and other industry groups. (NCW)

1972

1972

N74-18602 Citizens' Advisory Committee on Environmental Quality, Washington, D.C.
MAJOR R&D PROGRAMS TO MEET THE ENERGY CRISIS
Lelan F. Sillin, Jr. In Mitre Corp. Symp. on Energy, Resources and the Environment. Vol. 3 14 Apr. 1972 p 68-80 ref (for availability see N74-18598 09-34)

The review of restrictive environmental protection laws and regulations is advocated in order to construct and operate new power facilities that insure increased electric energy demands for future economic growth in the U.S. Long term payoffs for society require power supply systems which produce and transmit abundant, reliable and cheap power without depletion of natural resources. Research on the use of solar energy, fusion power, large scale production of hydrogen, or an optimum blending of several of these concepts is projected for future energy supply systems.

W74-73686

I

1972

RESEARCH AND DEVELOPMENT OPPORTUNITIES FOR
IMPROVED TRANSPORTATION ENERGY USAGE.
(Summary Tech. Rept.). September 1972.

Department of Transportation DOT-TSC-TMP

PB-220,612

Abstract: The almost complete dependence of transportation systems upon petroleum products makes the transportation sector vulnerable to increased prices of petroleum or insecure sources of petroleum. Since the dependence of transportation upon imported petroleum is projected to increase substantially over the next two decades, both short- and long-term remedial actions should be initiated now and in the next few years because of the long time needed to bring about evolutionary changes in the Nation's transportation systems. Possible remedial actions include:

1. Technological improvements for more efficient use of petroleum by transportation.
2. Technological changes to permit greater use of non-petroleum energy resources by transportation.
3. Shift of transportation demand to more efficient modes from less efficient modes.
4. Reduction of demand for transportation services.

Transportation energy demand projections are given and R&D tasks in each of the first three categories are assessed.

N-140,589 92d Congress, 2d Session

ENERGY RESEARCH AND DEVELOPMENT. Report of the
Task Force on Energy of the Subcommittee on Science
Research, and Development of the Comm. on Sci.
and Astronautics, U.S. House of Representative.
Dec. 1972. Committee Print.

Federal Funding for Research and Development of Fossil
Versus Nuclear Fuels used for Civilian Energy Production.
J. Dehner.

Cornell Univ., Ithaca, N.Y. Cornell Energy Project. Oct 71,
12p. Paper-71-14. NSF-RA/N-71-014
PB-228 856/1WE PC\$4.00/MF\$1.45

The appropriation of federal money to various agencies for
research and development of energy sources for the produc-
tion, conversion, and transmission of energy to be used for
civilian purposes is briefly summarized. The cost for the years
1963 and 1970 is covered, with more detailed expenditures
listed for FY-1970. It can be concluded from the data that
R&D programs for atomic energy received considerably more
money than did R and D programs for fossil fuels. (Author)

74N71662 71/11/00 223 PAGES UNCLASSIFIED DOCUMENT
ADVANCED AUTOMOTIVE POWER SYSTEMS RESEARCH AND DEVELOPMENT PROGRAM
ENVIRONMENTAL PROTECTION AGENCY, WASHINGTON, D.C. (DIV. OF
ADVANCED AUTOMOTIVE POWER SYSTEMS DEVELOPMENT.) AVAIL. NTIS
/*AUTOMOBILES/*POWER SUPPLIES/ ENERGY SOURCES/ RESEARCH AND
DEVELOPMENT

74N70438 66/03/00 23 PAGES UNCLASSIFIED DOCUMENT
ENERGY R&D AND NATIONAL PROGRESS: FINDINGS AND CONCLUSIONS. AN
INTERDEPARTMENTAL STUDY
OFFICE OF SCIENCE AND TECHNOLOGY, WASHINGTON, D.C. AVAIL. NTIS
♦ENERGY REQUIREMENTS♦ENERGY SOURCES♦UNITED STATES OF AMERICA/
ENVIRONMENT POLLUTION/ ENVIRONMENTAL QUALITY RESEARCH AND DEVELOPMENT/
RESOURCE ALLOCATION

73N71927 71/00/00 116 PAGES UNCLASSIFIED DOCUMENT
BRIEFINGS BEFORE THE TASK FORCE ON ENERGY OF THE SUBCOMMITTEE ON
SCIENCE, RESEARCH, AND DEVELOPMENT FROM SUBCOMMITTEE ON SCIENCE,
RESEARCH, AND DEVELOPMENT
COMMITTEE ON SCIENCE AND ASTRONAUTICS (U.S. HOUSE).
WASHINGTON GPO PRESENTED TO COMM. ON SCI. AND ASTRONAUT., 1970
CONGR., 1st Sess., 17 Dec. 1971
♦CONGRESS♦ENERGY REQUIREMENTS♦ENERGY SOURCES♦RESEARCH AND
DEVELOPMENT/ POLICIES/ TECHNOLOGY UTILIZATION

E. ENVIRONMENT

1974

The Futurist, v.VIII, no.1, Feb.1974.

Energy and the Environment
By Vaclav Smil 4

A survey of expert opinion on long-term aspects of energy and the environment provides a basis for a relatively optimistic picture of the energy situation in the years 1985 and 2000.

ENERGY VS. ENVIRONMENT. A CONFLICT IN CONGRESS.

D.E. Gushee.
Chemtech, Feb.1974, p.96-98.

The energy crunch raised a threat in Congress to environmental gains; but so far all still seems to be well.

AUTOMOBILE EMISSIONS ABATEMENT AND
FUELS POLICY.

R.K. Prud'homme.
Amer. Scientist, v.62, no.2, Mar./Apr.1974,
p.191-199.

The gasoline shortage is causing us to reconsider ways of meeting the 1975-76 clean air standards.

(CONF-740406-1) STUDY OF OPTIONS FOR CONTROL OF EMISSIONS FROM AN EXISTING COAL-FIRED ELECTRIC POWER STATION. Salmer, R.; Nichols, J. P. (Oak Ridge National Lab., Tenn. (USA)). 1974. 25p. Dep. NTIS \$4.25.
From second AEC pollution control conference, Albuquerque, New Mexico, USA (16 Apr 1974).
Alternatives for the reduction of sulfur oxide emissions from an existing 1300-MW coal-fired power station are compared with respect to technological feasibility, practicality, and cost. The principal options available for near-term (1975-1977) application are the use of (1) low-sulfur fuel oil derived from petroleum, or (2) low-sulfur western coal. The use of low-sulfur fuel oil is technologically feasible, but the long-term outlook is for continued scarcity, high price, and unreliability of supply. Operational problems with low-sulfur coal may cause derating of plants designed for eastern coals. Sulfur gas treating processes such as scrubbing with limestone slurry do not yet have the degree of operating reliability needed for power plant use. It is estimated that processes for treating stack gas may achieve 90% reliability by about 1976, but implementation by 1977 would require selection of a process and initiation of engineering by about 1974-1975. Among the longer-term options, low-Btu gas has the advantage of a high degree of sulfur removal and the potential for future use in cycles of high efficiency. Solvent refined coal appears to have considerable potential, assuming that pilot-plant operations are successful. Liquid fuels from coal have promise not only for power plant use but also for easing the long-term shortage of liquid fuels for the transportation sector. (auth)

N74-14094# Citizens' Advisory Committee on Environmental Quality, Washington, D.C.
REPORT TO THE PRESIDENT AND TO THE COUNCIL ON ENVIRONMENTAL QUALITY

Oct. 1973 48 p refs
Avail: SOD HC \$1.05

A report on the effectiveness of environmental protection methods is presented. The report was prepared for the President by the Citizens' Advisory Committee on Environmental Quality. The subjects discussed include: (1) actions taken to improve waste disposal; (2) land use action legislation; (3) environmental impact statements; (4) protection of agricultural lands; (5) city improvement efforts; (6) urban transportation systems; (7) preservation of historic features; and (8) energy conservation measures.

MATERIAL NEEDS AND THE ENVIRONMENT TODAY AND
TOMORROW.

The National Commission on Materials Policy
June 1973. GPO \$2.75. LC73-600202.

Chapter 5. Energy and Materials. p.5-3 - 5-22.

1973

TITLE: Power plants, Transmission lines, and the North American Environment

AUTHOR: Burgess, R.L.

CORPORATE AUTHOR: Oak Ridge National Laboratory, Environmental Sciences Division

ADDRESS: P.O. Box X, Oak Ridge, TN 37830

PUBLICATION DESCRIPTION: Paper presented at a symposium, Preparing Environmental Reports for Nuclear Power Plants, in Monterey, California, January 22-24, 1973, 20 p.

PUBLICATION DATE: 1973

SPONSOR: Eastern Deciduous Forest Block, US-18P; National Science Foundation

ABSTRACT: Although such attention is currently being given to environmental effects in the location of new power plant construction, very little is devoted to the effects of the associated transmission lines. The right-of-way required for most plant output far exceeds the land area of the plant itself. Careful planning of routes, using available vegetation maps, could do much to alleviate the environmental damage. (JNC)

THREE-WAY SQUEEZE ON THE ENERGY CONSUMER. Bloom, G. I. Pub. Util. Forum, 92: No. 9, 28-30 (25 Oct 1973).

In 1967, an imbalance between energy shortage, rapid inflation, and popular interest in ecology occurred. If the energy shortage or the ecological cleaning-up processes had occurred and been solved in the early fifties when prices were low, the tasks of regulators would have been easier. All three phenomena occurred at the same time, and each had an effect on the other. The definitions of environmentalists and ecologists are explained. The collision is between two aspects of the environment—ecology and economy. Consumers do not understand that increasing the electric bills are connected to the environment—the cleaning up of the environment without any increase in electric power production. (MCW)

CORNELL ENERGY PROJECT: NATIONAL ENERGY NEEDS AND ENVIRONMENTAL QUALITY. Progress Report, March 1, 1972 to June 1, 1973. Ithaca, NY: Cornell University (1973). 44p.

A summary of the third year of the Cornell Energy Project covers studies on biological and ecological costs, socioeconomic aspects of the energy problem; engineering and technology assessment, legal and institutional aspects of the energy problem; and educational and special program activities. It is concluded that the important needs for the future are: the assessment of actual health and environmental costs so that cost-effectiveness decisions can be made in a way that there will not be a waste of resources; public understanding so that there will not be pressures to eliminate imaginary risks at the cost of needed resources or acceptance of additional real risks; and development of an energy policy that will meet the short-term problems in such a way that the long-term problems will not be aggravated. (MCW)

1973

N74-11764 RAND Corp., Santa Monica, Calif. ENERGY DEMAND AND ITS EFFECT ON THE ENVIRONMENT

D. N. Morris. Jul. 1973 28 p (P-5048) Avail: NTIS HC \$3.50

An analysis of the current energy crisis and the possible environmental factors involved in the use of alternate sources of energy to reduce the consumption of fossil fuels is presented. Graphs are developed to show: (1) energy use in the United States, (2) total U.S. crude oil production from 1890 to 2050, (2) consumption of electricity in California, and (4) commercial, residential, and industrial electrical use in California. Measures for conserving electricity are proposed. The estimated national air pollution emission by source in 1969 is shown in table form.

ENERGY AND ECOLOGY. McLean, J. G. (Consultant Oil Co., Stamford, CT). Chem. Eng. Progr., 69: No. 5, 29-36 (May 1973).

Facts regarding the U. S. energy outlook are summarized and the accompanying economic and political implications of these facts are outlined. The energy-related domestic and foreign policies are discussed. A pragmatic approach to environmental problems created by the production and use of energy is suggested, namely: (1) striking a better balance between costs and social benefits in the pursuit of our environmental objectives, and (2) establishing more realistic time schedules for achievement of our environmental goals. (JCV)

N74-14791# Council on Environmental Quality, Washington, D.C. CN-140, OC4 ENERGY AND THE ENVIRONMENT: ELECTRIC POWER

Aug. 1973 66 p refs (PB-223326/OGA) Avail: NTIS SOD HC \$0.85 as 4111-00019 CSCL 13B

The conflict between energy needs and the environment poses a problem that must be solved by understanding the factors that influence demands for energy and by developing energy systems that meet these demands with minimal damage to the environment. This report considers the elements underlying our growing demand for energy and the environmental implications of the complex energy systems for meeting this demand. It focuses on electric energy because of the particularly rapid growth in this sector. GRA

VIKRAM DALAL, RCA Laboratories, Princeton, New Jersey, U.S.A.

1973

Environment, energy and the need for new technology: *Energy Conversion* 13, 85-94 (1973).

Summary—This paper examines the problem of energy and energy technology from an environmental viewpoint. The paper starts out by briefly reviewing the energy resource problem, and shows the need for a rapid development of newer fossil-fuel technologies, such as coal gasification. Next, we examine critically the various energy technologies, those which are popular today (e.g. nuclear water reactors, modified gasoline cars) and new technologies which are in early stages of development today (e.g. solar energy, electric cars, coal-gas powered advanced turbines). It is shown that several of the newer technologies have significant advantages over the presently popular technologies. These advantages include higher energy efficiencies and significantly lower environmental degradation. A model of the probable energy consumption patterns in 1990 indicates that the newer technologies, if developed, could have significantly lower resource depletion, air pollution and thermal pollution in 1990 as compared to the extensions of presently popular technologies. The problem of energy has also been viewed from the demand side. It is shown that the growth in demand cannot continue at the present rate without causing serious thermal imbalance over relatively large areas of developed society (e.g. the northeastern U.S., Western Europe). Some of the possible changes in our attitudes (e.g. more mass transportation, better natural design) that may be necessary to bring about a better balance between man and nature have been briefly discussed.

1973

Reviewing Environmental Impact Statements: Power Plant Cooling Systems, Engineering Aspects.

A. G. Christanson, F. H. Rainwater, M. A. Shirazi, and B. A. Tichenor.

Pacific Northwest Environmental Research Lab., Corvallis, Oreg. Oct 73, 101p W74-04555, EPA-660/2-73-016. Paper copy available from GPO \$1.35 as EPA-23-660/2-73-016. PB-228 604/SWE PC-GPO/MFS1.45-NTIS

This report describes the approach and technical base that have been used by EPA's National Thermal Pollution Research Program for reviewing those portions of Environmental Impact Statements (EIS's) relative to the engineering aspects (including economics) of cooling water systems for thermal power plants. Techniques and data are provided to enable the EIS reviewer to make sound judgements concerning the adequacy of both the cooling water system selected for the power plant and the EIS comments on that system. Literature citations are provided to direct the reviewer to additional and more detailed information. Information and discussions are provided on cooling system configurations, operation, environmental effects, and costs. Consideration is given to the intake as well as the discharge. (Modified author abstract)

CN-129,767 1973
THE ENERGY CRISIS. ENERGY VERSUS ENVIRONMENT.
Eric Hirst, ORNL. (Photostat).

The Living Wilderness Winter
P. 50-64 1972-73
Oak Ridge National Lab.

POWER SOURCES Environment Pollution

L-7-26-73

CN-129,822

(ORNL-NSF-EP-53) ENERGY IMPLICATIONS OF SEVERAL ENVIRONMENTAL QUALITY STRATEGIES. Hirst, E. Oak Ridge National Lab., Tenn., Jul 1973. Contract W-7405-eng-26. 34p. Dep. NTIS \$3.75.

The amounts of energy needed for or saved by operation of several environmental protection strategies are examined. The areas considered include: urban passenger traffic, waste water treatment, solid waste management, air-pollution control, and waste heat dissipation. The energy costs and savings of a shift to mass transit from automobiles, of automobile air-pollution-control devices, and of energy-efficient automobile designs are examined. Electric energy costs are determined for primary and secondary sewage treatment plants as functions of plant size. Energy costs and savings are computed for solid waste disposal, recycle, and use as fuel. Energy needs for air-pollution control at stationary sources are evaluated. Finally, several options for improving energy-use efficiency are noted. The energy required

to meet the environmental needs discussed is based on the limitations and assumptions in this study are small relative to total energy use. (auth)

N74-22615 #

(LA-5447-MS) ENERGY AND ENVIRONMENT: SYSTEMS AND PERSPECTIVES. Freiwald, D. A. (Los Alamos Scientific Lab., N. Mex. (USAI). Nov 1973. Contract W-7405-eng-36. 13p. Dep. NTIS \$4.00.

The concept of energy and environment is discussed from various perspectives, including space and time, energy systems development and natural resources, limits to growth, influence systems, the total environment, alternate schemes, and a communications structure. Brief discussions are presented as to how these subjects interrelate, and what types of programs might meaningfully ameliorate energy problems on a long-time scale. (69 references) (auth)

TK 2896, I55 1973

1973

TITLE: The Low Emission Car for 1975 - Enter the Diesel

AUTHOR: Springer, K.J.; Ashby, R.A.
CORPORATE AUTHOR: Southwest Research Institute
U.S. Environmental Protection Agency,
Emission Control Technology Division, Office
of Mobile Source Air Pollution Control
ADDRESS: 724, Ann Arbor, MI

PUBLICATION DESCRIPTION: Paper 71913 presented
at 4th Intersociety Energy Conversion
Engineering Conference held at University of
Pennsylvania, Philadelphia, PA, Aug. 13-17,
1973, p. 266-285 of Proceedings, 18 references

PUBLICATION DATE: 1973
SPONSOR: U.S. Environmental Protection Agency
ABSTRACT: Emissions from Mercedes automobiles
powered by four-cylinder diesel and
(four-cylinder) turbo (gasoline-fueled) engines
were measured and compared. Comparative
test of the gasoline and diesel vehicles
were also made. It was found that the diesel
engine, without any modification or special
tune-up, can meet CO, HC, and NOx emission
standards. Odor and smoke should be reduced.
Fuel economy was shown to be on the order of
70% better with the diesel-powered car than
with the average gasoline-powered car. (MPS)

AVAILABILITY: American Institute of Aeronautics
and Astronautics, Order Dept., 1290 Avenue of
the Americas, New York, NY 10019 (\$60.00 for
entire proceedings)

TK 2896, I55 1973

1973

TITLE: Emissions from Hybrid Vehicles

AUTHOR: Liddle, S.G.
CORPORATE AUTHOR: General Motors Research

Laboratories
ADDRESS: Warren, MI 48090

PUBLICATION DESCRIPTION: Paper 739115 presented
at 4th Intersociety Energy Conversion
Engineering Conference held at University of
Pennsylvania, Philadelphia, PA, Aug. 13-17,
1973, p. 235-242 of Proceedings, 9 references
PUBLICATION DATE: 1973

ABSTRACT: A study was made to determine the
emissions reduction potential of piston
and engine-electric hybrid vehicles. Series and
parallel hybrids were considered in a 4000
lb. vehicle. To facilitate this study, a
computer program was written which solved
the vehicle and, using engine test data,
computed its emissions and fuel consumption
over the 1972 FTP driving cycle, starting
with a fully warmed-up engine. This study
indicates that under certain conditions
emissions may be reduced for a hybrid vehicle
as compared to its conventional counterpart,
but under other conditions, they may be
increased. The extent of the reduction or
increase experienced with hybrid operation
depends on the particular pollutant and the
engine operating conditions. Unburned by as
hydrocarbons, for example, are reduced by as
much as 76%, depending on conditions, carbon
monoxide and oxides of nitrogen are shown
both to increase by up to 21% and to decrease
by up to 40%. Therefore, the hybrid vehicle
does not automatically guarantee lower
emissions. (auth)

AVAILABILITY: American Institute of Aeronautics
and Astronautics, Order Dept., 1290 Avenue of
the Americas, New York, NY 10019 (\$60.00 for
entire proceedings)

TK
2896
I55
1973

Intersociety Energy Conversion Engineering Con-
ference, 8th Philadelphia, Pa., 1973.
Proceedings. New York, American Institute of
Aeronautics and Astronautics [1973]
847 p. illus. 29 cm.

Held at: University of Pennsylvania, Philadel-
phia, Pa., August 13-16, 1973.
Sponsored by: American Institute of Aero-
nautics and Astronautics [and others]

Energy and the Environment - T. J. MARTIN 404

1973

TITLE: A Technology Assessment of Future
Automobile Engines

AUTHOR: Corlies, W.R.
CORPORATE AUTHOR: Miltan Associates Inc.

ADDRESS: Columbia, MD 21045

PUBLICATION DESCRIPTION: Summary of Miltan
Associates Report MTR-581, "A Technology
Assessment of the Transition to Advanced
Automotive Propulsion Systems", 102 p.
PUBLICATION DATE: 1973, January

SPONSOR: National Science Foundation
ABSTRACT: A technology assessment of the impact
of advanced automobile engines was conducted
by Miltan Associates, Inc., for the National
Science Foundation. The technique employed
involved generating seven scenarios of future
lines of automobile production between 1976
and 2000. Five algorithms (calculational
methods) were programmed on a computer to
forecast: (1) the six of the cars on the
road; (2) the impact on materials resources;
(3) the impact on energy resources; (4) the
impact on emission levels; and (5) the
socioeconomic impact. Impacts were measured
against a baseline provided by the internal
combustion engine (ICE) now common throughout
the world. (auth)

ENERGY AND OUR FUTURE. Seaborn, G. T. (Univ.
of California, Berkeley). Pub. Util. Forum, 91: No. 3, 13-17
(1 Feb 1973).

The wise use of energy can restore nature, help clean up the
environment, and rebuild cities. It can help toward a lasting
peace and push to new frontiers, not only in space but in the
mind and spirit of man. In the past, not enough thought was given
to equally balancing the use of energy with proper environmental
values. There is evidence that this is now changing. (auth)

74N21025# ISSUE 12 PAGE 1458 CATEGORY 34 GPC-20-345 73/09/CC
 64 PAGES UNCLASSIFIED DOCUMENT
 TRANSPORTATION CONTROLS UNDER THE CLEAN AIR ACT --- CONGRESSIONAL
 INVESTIGATION OF EFFECTS OF CLEAN AIR POLICY ON TRANSPORTATION
 COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE (U. S. HOUSE).
 AVAIL SUBCOM. ON PUBLIC HEALTH AND ENVIRONMENT
 WASHINGTON GPO PRESENTED TO COM. ON INTERSTATE AND FOREIGN
 COM., 93D CONGR., 1ST SESS., SEP. 1973
 /*AIR POLLUTION/*AUTOMOBILES/*CONGRESS/*POLLUTION
 CONTROL/*TRANSPORTATION/ ENERGY REQUIREMENTS/ EXHAUST GASES/ INDUSTRIAL
 ENERGY/ POLLUTION MONITORING

Dole, S.H. and R.A. Papetti. ENVIRONMENTAL FACTORS IN THE PRODUCTION
 AND USE OF ENERGY. Santa Monica, Rand, 1973. 77 p.

74N20697 ISSUE 12 PAGE 1377 CATEGORY 3 73/CC/00 151 PAGES
 UNCLASSIFIED DOCUMENT
 OPTIMAL ELECTRICAL ENERGY GROWTH STRATEGIES IN AN ERA OF
 ENVIRONMENTAL CONCERN PH.D. THESIS
 A/STAUCER, J. W.
 KANSAS STATE UNIV., MANHATTAN. AVAIL UNIV. MICROFILMS ORDER NO.
 74-6001
 /*ELECTRIC POWER/*ENERGY POLICY/*ENERGY REQUIREMENTS/ CCAL/ CCSTIS/
 ENVIRONMENT PROTECTION/ LINEAR PROGRAMMING/ NUCLEAR REACTORS

CN-140,486 1973
 ENERGY AND THE AUTOMOBILE. (Papers presented
 at a Forum, May 15, 1973, held as part of the
 1973 National Automobile Engineering Meeting,
 May 15, 1973, Detroit). July 1973. 73p.

Society of Automotive Engineers, SP-383
 Inc.

Automobiles
Engine emission
Engines, Automobile

L-4-1.-74

N74-20636 #

1973

(JUL-982-RO) APPROACH TO THE HOLISTIC ANAL-
 YSIS OF THE SYSTEM MAN-ENERGY-ENVIRONMENT. Voss,
 A. (Kerforschungsanlage Juelich G.m.b.H. (F.R. Germany).
 Inst. fuer Reaktorentwicklung). Jul 1973. 133p. (In German).
 Dep. NTIS (U.S. Sales Only) \$11.75.

Thesis.
 Energy is generally considered as the main access to the modern
 industrial society. The availability of sufficient amounts of energy
 is due to fundamental importance for the development of society.
 Besides the demand on economical energy maintenance, there are
 intensively occurring ecological and supply-technical aspects,
 whose importance advances permanently with the exponential in-
 crease of the energy consumption. A holistic analysis for the
 system man-energy-environment regarding economical, ecologi-
 cal, and technical aspects is presented. The aim is to comprehend
 all significant influence factors and interactions as well as to
 compare and to evaluate the positive and negative effects of an
 increasing energy consumption and its protection by alternative
 energy supply systems. For such complex systems new methods
 developed in the field of system engineering, especially cybernetic
 simulation, have to be used for the derivation of adequate aid for
 decision. (auth)

(WASH-1261) ENVIRONMENTAL IMPACT OF ELECTRICAL POWER GENERATION: NUCLEAR AND FOSSIL. A Minicourse for Secondary Schools and Adult Education. (Pennsylvania Dept. of Education, Harrisburg (USA)). 1973. Contract AT(40-1)-4167. 96p. GPO \$1.25.

The advantages and disadvantages of the methods of generating electrical power are discussed in the minicourse for secondary schools and adult education. The eight chapters are: The Demand for Electric Energy; Meeting the Demand for Electrical Energy; Nuclear Power Plants; Fossil Fueled Electrical Generating Stations; Biological Effects: A Comparison; Wastes in the Production of Electric Power; Plant Site Considerations; and Energy Conservation: The Need for More Efficient Use of Energy. Additional data are available in four appendices. (MCW)

CR-129, 738, Side III & IV (1973)
THE ENERGY CRISIS. (INCIS. SIDE III: THE DEMAND FOR SULFUR OXIDE CONTROL METHODS IN ELECTRIC POWER GENERATION. Robert M. Jimeson. SIDE IV: THE EFFECT OF DESULFURIZATION METHODS ON AMBIENT AIR QUALITY. Kurt E. Yeager. (Presented at the ACS Symp. on Environ. Pollution Control, Part I, Held at the 164th ACS Nat'l Meeting, N.Y., N.Y., Aug. 28-31, 1972). (Series title: ACS Audio Research Reports). (1973). Audiocassette.

American Chemical Society
Symposium on Environmental Pollution Aug. 28-31,
Control; Part I - The Energy Situation 1972
& Its Environmental Impact 193, 264

WHAT ARE THE REAL COSTS AND BENEFITS OF PRODUCING "CLEAN" ELECTRIC POWER? Alexander, M. O.; Livingstone, J. L. Pub. Util. Forum; 92: No. 5, 15-19 (30 Aug 1973).

An example of a systematic method of analysis for a pollution cost/benefit study is given, dealing with a leading electric utility in a major city. Although it was applied only to a single company, the same method can be used for any company. In the example, the benefits of pollution abatement substantially outweighed the costs to the public. This method provides information that does not appear in conventional accounting systems. It supplies facts for making a case to the public, government, and regulatory agencies that utilities are not out to thwart pollution control standards or to export higher prices from a resentful public, and thus provides a basis for positive public statements on the "real" cost of electric power. (DLC)

(WASH-1262) TEACHER'S GUIDE FOR THE ENVIRONMENTAL IMPACT OF ELECTRICAL POWER GENERATION: NUCLEAR AND FOSSIL. A Minicourse for Secondary Schools and Adult Education. (Pennsylvania Dept. of Education, Harrisburg (USA)). Nov 1973. Contract AT(40-1)-4167. 165p. GPO \$1.70.

Pertinent information relevant to decision making as to the generation of electrical energy using either nuclear or fossil fuels is summarized. The advantages and disadvantages of each method of electrical generation are discussed in relation to health hazards to the general population. The material was assembled for use as a teacher's guide for studies on the environmental impact of electrical power generation. (CH)

N-129 735-
(ONR-NSF-EP-55) ELECTRICAL ENERGY AND ITS ENVIRONMENTAL IMPACT. Progress Report, June 30, 1973. (Oak Ridge National Lab., Tenn.). Jul 1973. Contract W-7403-ENG-26. 67p. Dep. NTIS \$3.50.

Major results are placed on the analysis of energy uses in the residential and transportation sectors, but a new topic is the exploration of the energy cost of food that turns out to be several times larger than the energy content of food. The analysis of energy uses is discussed concerning energy requirements for environmental quality; energy costs of food; energy conservation; transportation energy; efficiency and economics of room air conditioners; residential energy; and a report on residential consumption of electricity, 1950 to 1970. The electricity demand in the USA and the TVA area are cited. An evaluation of alternative reclamation techniques for coal surface mining in Appalachia is made, along with its economical aspects and implementation. The disposition of trace elements from coal combustion at the TVA Thomas A. Allen Steam Plant in Memphis, Tennessee is being investigated. (JCN)

POWER CYCLE TO ELIMINATE THERMAL POLLUTION.
TAN, Potter, J. H. (Sevens Inst. of Tech., Hoboken, NJ).
J. Eng. Ind; 95: No. 1, 379-382 (Feb 1973).

A cycle is proposed in which no condenser cooling water is required. Turbine backpressure is kept to conventional levels by condensing the steam during the evaporation of a refrigerant. Heat is rejected from the refrigerating loop in air coolers. Application of this concept to an 826 MW fossil-fueled power station shows the anticipated increases in heat rate and capital cost. (auth)

1973

Technology Review, v.76, no.2

Dec. 1973

THE ENERGY CRISIS - special issue.

The Energy-Environment-
Economic Triangle 10
David C. White

The sources of today's energy "crisis" are far deeper than ill will in the Near East. The problems of exponential growth have many dimensions, and some of them still lurk near the horizon

L-3-1-74

(WASH-1261-14) ENVIRONMENT. Subpanel Report XIV Used in Preparing the AEC Chairman's Report to the President. Greenfield, S. M. (USAEC, Washington, D. C.). 13 Nov 1973. 46pp. Dep. NTIS \$33.25.

Two basic conclusions are drawn with respect to the challenge of preventing environmental degradation: first, development and implementation of energy systems for achieving and maintaining energy self-sufficiency clearly must be sensitive to the effects that the systems will have on health, welfare, and ecosystems. Second, if this sensitivity is rationally incorporated into the development and implementation of energy processes, these domestic resources can be broadly utilized in harmony with the environment. The achievement of this second point is the fundamental goal to which this environmental research agenda is directed. This agenda consists of four environmental science subprograms constructed by projecting presently known and anticipated concerns for the impacts of existing and developmental energy systems on the environment. These subprograms are: (1) pollutant characterization, measurement, and monitoring; (2) transport processes; (3) effects (health, ecological welfare, and social); and (4) environmental assessment and policy formulation. A total FY 1975-1979 funding level of \$663.7 million is broken down for each year for each subprogram. (LMT)

1973

TITLE: World Energy, The Environment & Political Action
AUTHOR: Wilson, T.V., Jr.
CORPORATE AUTHOR: International Institute for Environmental Affairs
ADDRESS: United Nations Plaza at 345 East 46th St., New York, NY 10017
PUBLICATION DESCRIPTION: 53 p. report
PUBLICATION DATE: 1973, January
SPONSOR: International Institute for Environmental Affairs; Aspen Institute for Humanistic Studies
ABSTRACT: This paper was prepared by Thomas V. Wilson, Jr. on the basis of the seven-weeks-long second International Environmental Workshop held at Aspen, Colorado, 26 June - 12 August 1972 under the co-sponsorship of the International Institute for Environmental Affairs and the Aspen Institute for Humanistic Studies.---The second workshop sought to develop an overview of the tangled world energy problem. The point of the exercise, however, was not to expose new aspects of the energy problem as such. It was, rather, to try to place that problem in the relevant contexts of environmental and international affairs and, from that perspective, to explore first avenues for political action to avert or diminish the potentially ominous implications for the relatively near future. This, it was hoped, might make a useful complement to the more detailed, more technical, and usually more circumscribed studies undertaken within governments and private research facilities. The focus on political-social implications explains why the present paper takes the form more of an essay than of a traditional expert report. "Hard data" can be found elsewhere, and a selected, annotated bibliography is appended for readers disposed to pursue the subject of energy, as such, in greater depth. (auth, free format)
AVAILABILITY: International Institute for Environmental Affairs, United Nations Plaza, 345 East 46th Street, New York, NY 10017

ENERGY PROBLEMS AND ENVIRONMENTAL CONCERN. Train, R. E. (Environmental Protection Agency, Washington, DC). Bull. At. Sci.: 29: No. 9, 43-47(Nov 1973).
The assertion that the energy crisis blame lies solely on environmentalists' blockage of new generating facilities and new refinery capacity is discussed. Blame involves other factors including prices, technology, regulatory requirements, international relations, and national security considerations. The consumer's role is discussed. Energy efficiency labels for major home appliances, automobiles, and automobile accessories are needed. A comparison of new-car gasoline mileage performance has been published by the EPA. (MCW)

ENERGY, ENVIRONMENT, AND GROUND TRANSPORTATION.

F.A. Creswick.
Research Outlook, v.5/no.1/1973/p.28-32.

104

Power Plant Thermal Effluents in Southeastern Lake Ontario.
Eugene E. Chermack, and Thomas A. Galletta.
State Univ. Coll., Oswego, N.Y. Lake Ontario Environmental
Lab. 1973. 13p NOAA-74042602 Pub. in Proceedings of
Conference Great Lakes Research (16th), p663-674 1973.
International Association Great Lakes Research.
COM-74-11024/8WE Reprint

Analyses of data taken by an airborne infrared thermometer
over the past two years are presented. The geographical region
of coverage includes power plant sites along Lake Ontario's
south shore from west of Rochester to the Mexico Bay area in
New York. This area is currently being developed to become a
major power generation corridor in the next ten years. Data in-
clude detailed surface thermal structure in the immediate
vicinity of four power plant outfalls as well as thermal struc-
ture of large areas of the lake adjacent to and lakeward of the
outfalls in order to provide baseline data. Particularly, analysis
has centered on the size, shape and behavior of the effluent
pools under varying wind, lake current and seasonal condi-
tions plus the ambient or background thermal field. (Modified
author abstract)

N74-14696f Committee on Banking and Currency (H.R.
House).
EPA POLLUTION REGULATIONS AND FUEL SHORTAGE:
THE IMPACT ON MASS TRANSIT
Washington GPO 1973. 689 p refs Hearings before Comm.
on Banking and Currency, 93d Congr., 1st Sess., 26, 30, and
31 Jul 1973

Avail: Subcomm. on Urban Mass Transportation
A hearing was held before the Subcommittee on Urban Mass
Transportation of the Committee on Banking and Currency of
the House of Representatives to discuss the Environmental
Protection Agency pollution regulations and the fuel shortage.
Specific emphasis was placed on the impact of the fuel
shortage on mass transportation and recommendations for
improving mass transportation as an energy saving measure.
Testimony from representatives of various petroleum companies
was presented to show the causes for the current fuel shortages
and steps being taken to improve the situation. The effects of
the proposals for reducing fuel shortages on the quality of the
environment are emphasized. Author

1973

CH-129,799 1972
U.S. TRANSPORTATION - SOME ENERGY AND ENVIRONMENTAL
CONSIDERATIONS. W.E. Fraize. (Prepared for pre-
sentation at the Symp. on Energy, Resources, and the
Environment, Kyoto, Japan, July 9-12, 1972). (Based
on Mire Corp. Rept. M72-25 - TRANSPORTATION: ENERGY
AND ENVIRONMENTAL ISSUES. W.E. Fraize and J.K. Duko-
vics. Feb. 1972). Sept. 1972. 43p. (also N74-19624 #)
N73-20991 #
Mire Corp. M72-164
Mire Corp. M72-25
Symposium on Energy, Resources, July 9-12,
and the Environment 1972

Abstract: The role of transportation in air
pollution and consumption of energy,
especially petroleum, is reviewed, with
emphasis on the U.S. situation. Both
technological and control measures for each
petroleum area are discussed. Technological
measures focus on the automobile, high speed
ground transportation modes, and
near-petroleum fuels, while control measures,
which encourage the use of the more efficient
transportation modes, are seen to offer
significant benefits. The near future is
discussed with respect to the impact of the
U.S. amended Clean Air Act of 1970.
Transportation evolution over the next few
decades is projected. (auth)

N72-31768# Bureau of Mines, Bartlesville, Okla. Energy
Research Center.
EMISSION CHARACTERISTICS OF PROPANE AS
AUTOMOTIVE FUEL
J. R. Allsup and R. D. Fleming [1972] 38 p refs
(BM-R1-7672; TN23 U7) Avail: NTIS HC \$4.00
(BM-R1-7672; TN23 U7)

Air pollutants in exhaust gas produced from L.P. gas (propane)
were studied using both laboratory engines and vehicles. The
objective was to evaluate engine parameters relating to the
adventurous use of propane as a low-pollution fuel. Some
comparisons are made between gasoline, natural gas, and
propane. Results show that engines can operate over a wider
range of A/F with minimum carbon monoxide and hydrocarbon
emission when using propane than when using gasoline. Mixture
enrichment using propane is unnecessary during cold starts,
thereby eliminating the emission penalty during warmup. Carbon
monoxide and hydrocarbon emission using propane are unaffected
by ambient temperature. The photochemical reactivity of
hydrocarbon emission is considerably lower with propane than
with gasoline. Author

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1972
Intersociety Energy Conversion Engineering
Conference, 7th, San Diego, Calif., 1972.
Proceedings. Washington, D. C., American
Chemical Society, 1972.
1533 p. illus. 28 cm.

The Resource, Environmental, and Socioeconomic Impacts of a Transition
from the ICE to Various Advanced Automotive Propulsion Systems
W. R. Merchant, J. P. Dorethy, K. M. Campo. P. 1003-

N74-18597 Mine Corp. McLean, Va.
ENVIRONMENTAL ISSUES. AN OVERVIEW
Richard S. Giesley. In: *Symp. on Energy, Resources and the
Environment*, Vol. 2, 13 Apr. 1972. p 186-208 (For availability
see N74-18591 09-34)

The environmental issues discussed are: (1) Waste heat and
its effect on temperature of the earth; (2) air pollution by sulfur
sulfur and auto emissions; (3) radioactivity in catastrophic accident
and local release; at background levels, and in the future problem;
(4) power plant and industrial facility siting; (5) strip and open
pit mining; (6) offshore exploration and drilling; (7) wilderness
and remote area exploration; and (7) zero growth perspective. It
is concluded that in the long run the conservation of energy is
order to progress the development. Gooding has overestimated and
the research and development to find alternative resources will
reduce the energy cost factor markedly. G.G.

N74-18598 Mine Corp. McLean, Va.
ENVIRONMENTAL ISSUES AND INSTITUTIONAL AR-
RANGEMENTS In: *Symp. on Energy, Resources and the
Environment*, Vol. 2, 13 Apr. 1972. p 90-135 (For availability
see N74-18591 09-34)

A comprehensive set of energy, resource and environmental
issues is presented. Some changes to governmental institutions
for dealing with the energy crisis are described that encompass
pricing, depletion allowances, oil imports, and environmental
regulators. G.G.

EN-129, 865
Title: Future Energy Demand and Its Effect on the
Environment
AUTHOR: Morris, D. N.
CORPORATE AUTHOR: Rand Corp.
ADDRESS: Santa Monica, CA 90406
PUBLICATION DESCRIPTION: R-1098-NSP, report of
the panel on Growth Rate of Energy Demand,
Cornell Workshop on Energy and the
Environment, February 22-24, 1972, 46 p.

ENVIRONMENTAL DATA: 1972, September
SPONSOR: National Science Foundation
ABSTRACT: The third panel began its deliberations
with an analysis of forecasts of energy
demand made in the last few years. They
reached the conclusion that these studies are
deficient for several reasons: First, most
fuels are assumed to have limitless supply
and constant prices; second, the impact of
new technology is not fully included; and,
third, environmental constraints are not
adequately taken into account. To overcome
some of these difficulties, the panel
developed three scenarios of energy demand
forecasts, each based on a different set of
assumptions. Several observations can be
made from these scenarios: First, various
levels of total energy use imply different
levels of per capita use; second, each level
of demand implies a different level of
environmental quality; finally, while demand
in the short term is easily predicted, demand
projections of the middle and far future
cannot be made without explicit recognition
of the impact of resource depletion and
environmental protection costs upon energy
prices. (From Sen. H.H. Jackson's memorandum
at beginning of published Summary Report)

N74-18594 Mine Corp. McLean, Va.
ISSUES INVOLVED IN DEVELOPING AN ENVIRONMENTAL
ETHIC
S. David Freeman. In: *Symp. on Energy, Resources and the
Environment*, Vol. 2, 13 Apr. 1972. p 68-89 (For availability
see N74-18591 09-34)

Issues involved in developing energy and environmental ethics
rest on a basic collision of values between a society that is
built on an abundant supply of energy and a society that has
adopted an environmental concern. It is shown that the U.S.
consumes thirty to thirty-five percent of the world's resources
each year with six percent of the world's population and that
the rest of the world is two-thirds in a perpetual blackout. A
policy of conservation and saving, and a more even distribution
of the world's resources necessitates inherent redistribution of
wealth until research and development efforts produce more
environmentally compatible sources of energy. G.G.

1972

1972

1972

N74-18691 National Center for Atmospheric Research, Boulder, Colo. Lab of Atmospheric Science.
WHAT WE CAN SAY ABOUT CLIMATE CHANGE
 William W. Kellogg In *Atmos. Corp. Symp. on Energy, Resources and the Environment*, Vol. 3 14 Apr. 1972 p 31-67 ref (For availability see N74-18598 09-34)
 Possible climatic changes due to very large amounts of man made energy release are considered. It is shown that most changes made to the surface of the earth result in more solar radiation absorption and that addition of any particles to the earth atmosphere probably results in a cooling effect. It is possible that this particle release may be a remedy for the man made warming trend on earth which could eliminate the Arctic ice pack and create an open Arctic Ocean with changes in atmospheric circulation patterns. G.G.

ENERGY AND THE ENVIRONMENT: A LONG-RANGE FORECASTING STUDY. Seel, V. J. University Park, PA: Pennsylvania State Univ. (1972). 27p. University Microfilms Order No. 72-33,204.
 Thesis (Ph. D.).

A relatively concise overview of potential developments in energy industries and their multitudinous environmental impacts was made. While specialized engineering analyses of past trends abound, and descriptions of environmental consequences of energy production have become increasingly common in the last several years, broad, long-range inquiries into the future of energy and environment are very rare. Although necessary as a base, it was felt that any attempt to fill this gap could not just be based on a summary and evaluation of the piecemeal information widely scattered through the many current publications dealing with energy and environment. A complex and original long-range forecasting study seemed to be needed. The conclusions and recommendations given are, thus, to a large degree based on the results of the first international long-range forecasting study of energy and the environment. The Delphi forecasting method was employed successfully in this study, where forty experts from seven nations participated in three rounds of questioning lasting almost a year. Delphi provided results in four separate, though highly interrelated, areas of interest. Long-range probability forecasts were obtained for thirty energy production, transmission, and transportation technologies and thirty-one environmental protection, planning and management innovations. Percentage probabilities of five environmental episodes — urban air pollution, power supply failure, jungle timber wreck, offshore drilling of oil, nuclear radiation contamination — were estimated for the 1970's. Finally, a relative ranking of the twenty-five most important energy-environment problems was established by the iterated Delphi procedure, and future growth limits of seventeen contemporary technologies were forecast by the energy systems experts. (Diss. Abstr. Int.,

44-28,691
 TITLE: Summary Report of the Corneil Workshop on Energy and the Environment (February 22-26, 1972)
 CORPORATE AUTHOR: U.S. Senate, Committee on Interior and Insular Affairs
 PUBLICATION DESCRIPTION: Serial No. 92-23, Workshop sponsored by the National Science Foundation, research applied to National Needs (RANN) Program, pursuant to S. Res. 45, A National Fuels and Energy Policy Study
 PUBLICATION DATE: 1972, May
 SPONSOR: National Science Foundation, RANN Program
 ABSTRACT: This Committee print represents the summary finding of four workshop panels, each of which was given a specific task: Panel 1 was to weigh the probable social, environmental, and biological costs involved in the various options available for satisfying energy needs; Panel 2 was to assess the technological options now known or foreseeable for dealing with these problems; Panel 3 was to gauge the probable course of energy demand and supply over the next several decades and evaluate the prediction systems now used for this purpose; and, Panel 4 was to examine the existing institutional structures for dealing with energy and environmental problems and to test the fit between newly identified problems and existing mechanisms and suggest new mechanisms which might require legislative or administrative action. (Met)

CM-129,069 1972
ENVIRONMENTAL RESEARCH IN THE POWER INDUSTRY THE MANUFACTURERS' ROLE. (Presented at the 1972 Winter Meeting, N.Y., N.Y., Feb.1,1972). 1972. 3p.

Institute of Electrical and Electronics Engineers
 Institute of Electrical and Electronics Engineers
 Engineering Society

Generators, Steam
 Electricity
 Power sources
 Environment
 (Paper)
 TCM0695-7-74R
 Special Publication
 L-11-3-72

RESOURCES LETTER ERPEE-1 ON ENERGY: RESOURCES, PRODUCTION, AND ENVIRONMENTAL EFFECTS. R.H. Rohrer. Amer. J. Physics, v.40/6, June 1972, p.805-829.

(NP-10823) ENERGY, RESOURCES, AND THE ENVIRONMENT. Zimmet, C.A. (MITEE Corp., Molena, Va. (USA)). Dec 1971. 3pp. (E-72-180)Dew. \$9.

A educational pamphlet presented at eight symposia held during the period July 1971 to July 1972 on the interrelationships of energy, resources, and the environment. Topics discussed include the growth of energy and the long-term situation, future outlook for energy and resources, the interrelationship of energy resources, environment, transportation, the energy crisis in the near future; options for the long term; transportation; and short and long-term problems. (HC6)

Meyer, Robert E.

Carrie Palmer Weber Junior High School, Port Washington, NY

How we can best meet our future energy needs: The environment and education.

Institute of Environmental Sciences. Mt. Prospect, Ill. Tutorial Proceedings: 39-41, 1972.

Sum., reiss. from Text & SS.

FUELS: EDUCATION: POWER GENERATION: energy sources: school science curricula.

Energy sources, the methods of production and use, and their effects upon the environment should be an important segment of environmental education. Educational institutions can play important roles in the stimulation of the use of nonpolluting energy sources. Potential nonpolluting resources using natural energy flows include gas turbines, aerogenerators, geothermal systems, tidal systems, and wind operated systems. Other promising systems are fuel cells, magnetohydrodynamics, solar energy, thermionics, thermoelectric energy, fast breeders, shale oil, coal liquification, coal gasification, and thermonuclear fusion.

PLANT SITING: A KEYSTONE ELEMENT IN THE ARCH OF SYSTEM PLANNING AND ENVIRONMENTAL CONTROL. Sporn, P. pp 3-12 of Power Plant Siting: Its Impact on System Planning and the Environment. New York: Inst. of Electrical and Electronics Engineers (1971).

From meeting on power plant siting, its impact on system planning and the environment; Portland, Oregon, USA (22 Jul 1971). See CONF-710742-1).

The development of Con Edison from the capacity of 792 kW in 1882 to a capacity of 8,273 MW within the confines of New York City in 1967 is followed. System generation and transmission diagrams of three integrated systems are discussed, namely the New England Electric System, the Middle South Utilities System, and the American Electric Power System. Plant siting has a large effect on system planning, but system planning has an enormous effect on plant siting. (MCW)

THE CRISIS IN POWER PLANT SITING.

M.M. Yarosh, ORNL.

Mechanical Engineering, v.93, no.6, June'71, p.10-13.

ENERGY TECHNOLOGY TO THE YEAR 2000: PART II: ENERGY AND POLLUTION.

Must Fossil Fuels Pollute. H. Perry and H. Berkson. p.34-43.

Heat the Ultimate Waste. D.R.F. Harleman and R.M. Parsons. p.44-51.

Capturing Sulfur During Combustion. A.M. Squires. p.52-60.

Technology Review, Dec. 1971.

1971

ENERGY AND THE ENVIRONMENT: THE DILEMMA OF THE STATE UTILITY REGULATOR. Ward, W. F. pp 17-19 of *Power Plant Siting: Its Impact on System Planning and the Environment.* New York: Inst. of Electrical and Electronics Engineers (1971).

From meeting on power plant siting, its impact on system planning and the environment; Portland, Oregon, USA (22 Jul 1971). See CONF-710742-1.

The state utility regulator is charged with the protection and enhancement of the quality of the state's waters, land, and air without specific mandates stating this order in these terms. Some experiences of the utility regulator in Michigan are reviewed and include warnings that energy can no longer be taken for granted in a finite world and will not continually be cheaply available for all current and projected demands. Regulators have to stand by and watch environmentally oriented inventors utilize patent procedures, often neglecting important factors. The utility industry is admonished for spending more for advertising than for research and development. (MCW)

N72-11866/ Oak Ridge National Lab. Tenn. THE ENVIRONMENT AND TECHNOLOGY ASSESSMENT Progress Report. Jun-Dec 1970

Feb. 1971 251 p 16th (Contract W-7405-eng-26; NSF Order AAA-R-4-79) (ORNL-NSF-EP-3) Avail: NTIS

A study of electrical energy consumption patterns, processes, and economics in highly developed countries is presented. The relationship between consumption of non-renewable resources and environmental degradation which occurs with an increase in energy consumption is discussed. Serious questions about the desirability as well as the practicality of continuing current patterns of energy consumption and growth are examined. Author

ENERGY CRISIS: THE ISSUES AND A PROPOSED RESPONSE. McClelland, Michael. Environ. Aff. 1: No. 3. 567-604/Nov 1973.

The environmentalists' view, as opposed to industrialists' views, of the energy crisis are presented. Environmentalists contend that: the crisis lies in the need to halt excessive pressures for increased consumption; the present rate of energy growth is unrealistic, environmentally damaging, and artificially induced; and there are reasonable ways to bring this rate of energy growth under control. Arguments and data to support each of these contentions are discussed. (L.C.L.)

POWER SYSTEM FACILITIES: THEIR IMPACT UPON ECOLOGY. Berry, P. S. pp 13-16 of *Power Plant Siting: Its Impact on System Planning and the Environment.* New York: Inst. of Electrical and Electronics Engineers (1971).

From meeting on power plant siting, its impact on system planning and the environment; Portland, Oregon, USA (22 Jul 1971). See CONF-710742-1.

The conservationist's concept of growth is discussed in view of its need and its impact on ecology; the real need when confronted with the demand for additional power plants or oil is discussed. An economy based on production for consumption's sake must be questioned. Conservation is concerned essentially with the quality of life, measured in terms of quieter, noncommercial and essentially nonmaterialistic values. The author feels that there are plenty of legitimate profits to be made, not just in cleaning up the pollution but in providing those necessary and continuing services to industry and communities that will permit the most conservative use of our natural resources in the future. (MCW)

POWER PLANT SITING: ITS IMPACT ON SYSTEM PLANNING AND THE ENVIRONMENT. 1971 Summer Meeting of IEEE, Portland, Oregon, July 22, 1972. New York: Institute of Electrical and Electronics Engineers (1971). 28p. (CONF-710742-1). \$3.00.

Separate abstracts were prepared for the three papers presented at the third session of the Power Engineering Society, Portland, Oregon, July, 1971. (MCW).

**CR-129,936 1971
CITIZENS' ADVISORY COMMITTEE ON ENVIRONMENTAL QUALITY. (Report to The President and to The Council on Environmental Quality). Apr-1971. 56p.**

**Citizens' Advisory Committee on Environmental Quality
Council on Environmental Quality
(Executive Office of the President)**

Environment

**Pollution
Power sources**

LAND USE

Reports, Presidential

1971

TITLE: The Energy Needs of the Nation and the Cost in Terms of Pollution

AUTHOR: Ramsey, J.Y.

CORPORATE AUTHOR: U.S. Atomic Energy Commission
PUBLICATION DESCRIPTION: Address presented at Georgetown University Seminar Series "Who Controls the Future of Science", Washington, DC October 28, 1971, reprinted in ABC News Release, 2(47), 8-10

PUBLICATION DATE: 1971, November 28

ABSTRACT: The nature of the energy crisis is reviewed, along with why it is essential to resolve this crisis and the environmental crisis. Included in the discussion are: the use of energy, where it is used, increase in use, future energy requirements, and energy resources to meet future needs. The impact of energy use on the environment is considered, including air pollution, waste heat, radioactivity, and other effects. The need for careful benefit-risk evaluations of ways to meet energy needs is emphasized. Other major energy problems are listed including power plant siting, research and development priorities, industrial concentration in the energy field, supply of energy from foreign sources, and overall energy policy and government organization.

"Energy and the Environment: Where Do We Go From Here?" David Freeman.

IEEE Trans. on Industry and General Applications, Vol. IGA-7, Sept./Oct. 1971 pp. 565-569.

PC33.86/MF30.95
PB-268 238
Environmental Protection Agency, Research Triangle Park, N.C. Office of Air Programs.
AN ANALYSIS OF THE ENERGY/FUELS SUPPLY AND DEMAND SITUATION IN SELECTED AIR QUALITY CONTROL REGIONS OF THE NORTHEAST CORRIDOR.
May 71. 127p. AFTD-6977

Descriptors: (*Electric power demand, *Fuel consumption), (*Pulch, *Reserve), (*Supply (Economic), *Fuels), Fossil fuels, Fuel oils, Residual oils, Natural gas, Thermal power plants, Nuclear power plants, Air pollution, Abatement, Fossil fuel deposits, Coal, Economic analysis, Demand (Economic), Taxes, Sulfur.
Identifiers: *Northeast Corridor, *Air pollution abatement, *Low sulfur fuels, Air pollution economics.

The report examines the energy requirements and supplies (especially fossil fuels) needed to jointly meet both energy and air quality requirements in

seven air quality control regions within the Northeast Corridor during the 1970-1975 period. The Northeast Corridor includes the east coast of the United States from Boston to Washington. This area encompasses all or at least a major part of the air quality control regions of Boston, Providence, Hartford, New York, New Jersey, Philadelphia, Baltimore, and Washington. The essential purpose of the study is to identify major gap areas in near term fuel use and projected supply requirements considering both the need for energy and the need for environmental protection. An equally important objective is to provide recommendations with respect to specific steps needed to be taken in order to fill energy gaps in an environmentally acceptable manner as revealed by the study. (Author)

NEPA (National Environmental Policy Act): Some Legal Constraints as Set Forth by the Court in Calvert Cliffs.
Judith A. Best.

Cornell Univ., Ithaca, N.Y. Cornell Energy Project. Oct 71.
26p Paper-71-12. NSF-RA/N-71-006
PB-228 865/2WE PCS3.25/MF31.45

This paper examines the expanded jurisdiction and duties of the federal agencies under the National Environmental Policy Act (NEPA) and analyzes the implications for judicial review. NEPA has substantially enlarged the jurisdiction of the federal agencies and created new substantive and procedural duties designed to prevent and eliminate environmental damage. The most important consequence of NEPA is that it shifts the burden of proof to the initiator of energy producing projects; this shift is based upon the policy that those who would disturb the environment must be able to justify their proposed activities. In the most important post-NEPA case to date, Calvert Cliffs v. AEC, the court broadly construed the new NEPA duties and adopted the view that NEPA applies to existing programs and ongoing activities. This case is analyzed in detail because it contains the most systematic interpretation of NEPA made by the federal courts and because the court interpreted the law as a shift in national priorities. (Modified author abstract)

National Energy Needs and Environmental Quality.

Peter L. Auer.

Cornell Univ., Ithaca, N.Y. Cornell Energy Project. May 71.
35p Paper-71-6. NSF-RA/N-71-006
PB-228 884/3WE PCS4.75/MF31.45

The report is concerned with today's problems in the energy sector of our economy which center around the increasing demands for energy (particularly electricity), the difficulties in meeting these demands, and the environmental effects of energy production. The efforts of the Cornell Energy Project directed toward solving these problems are reviewed in terms of economic, technological and biological constraints. (Modified author abstract)

73V26544 1971 ISS 00 FK1078.H4 621.4835 LC-72-200886

HEAT TRANSFER ASPECTS OF COMMERCIAL POWER GENERATION #BY: R. C.

AHLERT #AND OTHERS: KENNETH L. ADLER, JOHN C. CHEN #AND: M. L.

GRIEBENOM, EDITORS.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, NEW YORK, V, 143 P. ILLUS.
28 CM.

CHEMICAL ENGINEERING PROGRESS SYMPOSIUM SERIES, NO. 119, V. 67, 1971
"PAPERS ... PRESENTED AT THE 1971 ANNUAL MEETING OF THE AMERICAN
INSTITUTE OF CHEMICAL ENGINEERS." INCLUDES BIBLIOGRAPHIES.

LC ATOMIC POWER-PLANTS -- CONGRESSES. HEAT -- TRANSMISSION --

CONGRESSES. THERMAL POLLUTION OF RIVERS, LAKES, ETC. -- CONGRESSES.

ADDED AHLERT, R. C., 1932- ADLER, KENNETH L., ED. CHEN, JOHN C.,

1934- ED. GRIEBENOM, M. L., ED. AMERICAN INSTITUTE OF CHEMICAL

ENGINEERS. CHEMICAL ENGINEERING PROGRESS SYMPOSIUM SERIES, NO. 119.

MAIN-TITL TRACE-SERS*CORP*TITL*AUTH* CATALOG BY-LC

N71-31800f Bettis Memorial Inst. Columbus, Ohio.

THE FEDERAL R AND D PLAN FOR AIR POLLUTION
CONTROL BY COMBUSTION-PROCESS MODIFICATION

Final Report

11 Jan. 1971 352 p refs

(Contract CFA-22-69-147)

(PB-198008; APTD-0843) Avail: NTIS HC \$6.00/MF \$0.95

CSCIL 138

Results are reported of a study conducted for the Air Pollution Control Office to (1) identify gaps in combustion technology and (2) recommend a 5-year plan with priorities for effectively allocating resources for APCO supported combustion R and D directed toward meeting projected needs for air pollution control of energy conversion system by combustion modification. Combustion applications considered as elements of the plan include: central station power generation; industrial processing; industrial steam generation; commercial and residential heating; gas turbines and external combustion engines; and reciprocating internal combustion engines. A 5-year plan of combustion R and D is presented, with R and D opportunities identified and ranked in five priority levels.

N72-30071f Brookhaven National Lab. Upton, N.Y.
ECOLOGICAL EFFECTS OF ENERGY: A BASIS FOR
POLICY IN REGIONAL PLANNING

G. M. Woodwell and C. A. S. Hall [1971] 15 p refs
(BNL-10226) Avail: NTIS

The ecological effects of energy and establishment of a base for policy in regional planning are discussed. It is determined that the maintenance of the physical, chemical, and biotic integrity of the environment, regionally and earth wide, is a major consideration in planning any human activity and especially in planning for energy. Stability is an objective because the alternative, progressive degradation of the environment, is unacceptable. A wide spectrum of new laws governing the ecology may be required to produce the desired results. Author

74V24549 1971 ISS 00 10427. H4B7 C-675098-15-7 62E.168 LC-76-161673

A/BROWN. THEODORE L.

ENERGY AND THE ENVIRONMENT BY THEODORE L. BROWN.

MERRILL COLUMBUS, OHIO, IX, 141 P. ILLUS. 23 CM.

RADIOGRAPHY P. 127-134.

LC THERMAL POLLUTION OF RIVERS, LAKES, ETC. HEAT BUDGET (GEOPHYSICS)

WASTE HEAT.

MAIN-AUTH TRACE-TITLE* CATALOG BY-LC

/ /

1970

"Energy, the Economy, and the Environment"
David C. White

Technology Review: Vol. 74, No. 1 Oct./Nov. 1971.

pp. 18-31.

N71-29852/ Atomic Energy Commission, Washington, D.C.
ENERGY SOURCES OF TOMORROW
W. E. Johnson In its Proc. of the 11th AEC Air Cleaning Conf.
Vol. 2 Dec 1970. p 459-488 (See N71-29851 17-131)
Avail: NTIS HC\$6.00/MF\$0.95
The energy required in the USA in the future to keep the environment habitable for an expanding population and the relation between our environment and energy are discussed. It is concluded that 8 times the present electric energy capacity will be needed by the year 2000 to clean the environment and to maintain a reasonable standard of living for the additional population. Methods must be found for producing, distributing, and both cleanly and economically using fossil fuels. The more efficient breeder reactors must be developed for the economic use of nuclear fuels in commercial power plants. Finally, a nationally coordinated system for planning, developing, constructing, financing, and operating power plants is needed to achieve both the future electric energy needs and the environmental compatibility requirements. NSA

72V37923 1970 ISS 00 10427. H4B7 C-675098-15-7 62E.168 LC-70-609216

ELECTRIC POWER AND THE ENVIRONMENT: A REPORT, SPONSORED BY THE

ENERGY POLICY STAFF, OFFICE OF SCIENCE AND TECHNOLOGY, IN COOPERATION

WITH ATOMIC ENERGY COMMISSION AND OTHERS.

UNITED STATES. OFFICE OF SCIENCE AND TECHNOLOGY. ENERGY POLICY

STAFF.

FOR SALE BY THE SUPT. OF DOCS., U.S. GOVT. PRINT. OFF. WASHINGTON:

XI, 71 P. 27 CM.

\$0.75

LC ELECTRIC POWER-PLANTS -- ENVIRONMENTAL ASPECTS -- UNITED STATES.

BUILDING SITES -- UNITED STATES. POLLUTION -- UNITED STATES.

ADDED NUS***

MAIN-CORP TRACE-TITLE* CATALOG BY-LC

112

THE FUTURE OF VEHICULAR POWER PLANTS

Ernest S. Starkman /in Ariz. Univ. Proc. of Air Pollution-Control Seminar 13 Feb. 1970 p 12-52 refs (See N70-39313 22-04)

Avail: NTIS

The automobile is discussed with relation to its comparative role in air pollution, including the pollutants contributed and their effects. Revisions in engine operation to reduce air pollution are mentioned, and it is noted that as the levels of carbon monoxides and unburned hydrocarbons were being lowered, nitrogen oxide levels increased. Federal and state controls are described, and future air quality is predicted. The slow rate at which pollution control can be realized through the modification of new vehicles alone is suggested. Powerplants possible for automobiles other than internal combustion engines are described, including the electric vehicle and associated problems, steam engines, gas turbines, Wankel and Stirling engines, and engines using natural gas as fuel. Accomplishments in pollution reduction due to conventional engine controls are discussed, and past and future relative pollutant production from automobiles is compared with that from stationary sources. Graphs illustrate the presentation, and a bibliography is included. P.A.B.

ENGINEERING OF ENERGY EFFECTS WITH AN EXPANDING WORLD POPULATION, Bierthle, J. W. (Mechanical

Tool, Inc., La Grange, NY). pp 6.1-6 of Energy '70, Proceedings, Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From 6th annual Intersociety energy conversion engineering conference, Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

The life-quality problems associated with an exponentially expanding world population and its energy needs are discussed by considering energy uses, energy sources, uses of energy, the heat balance between the earth and its atmosphere, sources and effects of heat release, and engineering approaches to analyzing and systematically proposing solutions to these multiple problems. (L.C.L.)

N71-32625# George Washington Univ., Washington, D.C. LEGAL, ECONOMIC, AND TECHNICAL ASPECTS OF LIABILITY AND FINANCIAL RESPONSIBILITY AS RELATED TO OIL POLLUTION Final Report

Dec. 1970 347 p refs (Contract DOT-CG-10255-A)

(PB-198775: USCG-OIL-70-2) Avail: NTIS HC \$6.00/MF \$0.95 CSCL 13B

An intensive study of the oil pollution problem in its legal, economic and technical aspects is presented. The contents include the following: Analysis of the water quality improvement act; Theories of liability and their relation to oil pollution; Potential problems of the act; Jurisdiction; Economic principles of liability and financial responsibility for oil pollution; Oil pollution prevention and carrier liability; Economic models for analysis of problems; Relationships between cleanup costs and quantity of oil spilled; Measures of the potential economic loss from pollution; International trade implications of U.S. policies; The nature, behavior, and ecological effects of oil spills; Method for containment and cleanup of oil spills; and Oil pollution prevention and the characteristics of the oil industry production, transporting, and storage facilities.

N71-29471# Committee on Public Works (U.S. Senate).

SOME ENVIRONMENTAL IMPLICATIONS OF NATIONAL FUELS POLICIES

Washington GPO 1970 74 p refs Presented by Comm. on Public Works, 91st Congr., 2d Sess. Dec. 1970 Avail: SOD \$0.30

An objective analysis of the factors relevant to the development of fuels and energy policies compatible with environmental quality requirements is presented as a staff report to the Chairman of the Committee on Interior and Insular Affairs. Based on the expected population growth, the energy and fuel requirements are projected to the year 2000. Techniques and processes for pollution control are discussed, and the expenditures for pollution research are summarized for FY 1969, 1970, and 1971. F.O.S.

ENERGY AND THE ENVIRONMENT IN ELECTRIC

POWER GENERATION, Gerber, Abraham (National Economic Research Associates, Inc., New York), pp 18.1-4 of Energy '70, Proceedings, Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From 6th annual Intersociety energy conversion engineering conference, Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

Environmental problems connected with electric power generation are discussed by considering the growth of electric power production and use in the U. S.; the environmental effects of increased generating capacity using fossil or nuclear fuels; the higher cost of electric power generation resulting from the need to control environmental impacts; the future developments, such as MHD technology and cryogenic transmission, which may provide the means for partially offsetting the high cost that environmental controls will impose on electric power supply. (L.C.L.)

Energy, Air Quality and the System Approach, by Guy Black, George Washington Univ., Wash., D.C., Program of Policy Studies in Science and Technology, July 1970, 92p, \$3.00 PB-195 797

Stresses the close connection between air quality and the use of fuel as an important and useful central theme in air pollution analysis. Discusses reduction of sulfur in fuel, technology for reducing carbon dioxide, technology and economics in energy system choices, problems of system implementation, and the federal role.

F. CONSUMPTION AND ECONOMICS

1974

1974

ENERGY AND ECONOMIC GROWTH: HOW CLOSE THE RELATION. Dillaway, A. J. Energy Int., 11: No. 3, 21-23(Mar 1974).

The parameters involving the determination of a country's economic health are varied. The primary or secondary energy usage could be used to calculate the per capita use. The GNP and primary energy use for the years 1963 and 1970 are tabulated for Turkey, Portugal, Greece, Italy, Netherlands, and Sweden. Energy use relative to the gross domestic product before the oil crisis for various sections of Europe are given for the year 1968 and a projection of the 1980-1982 period. The contrasting relationship between electric energy consumption, economic activity, and total use of primary energy for 1968 to 1980 is shown. (MCW)

(OBNL-NEF-EP-69) ENERGY USE FOR BICYCLING. Hirst, E. Oak Ridge National Lab., Tenn. (USA). Feb 1974. Contract W-7405-eng-38. 33p. DTIC \$3.25.

Total energy use for bicycling—food, bicycle manufacture and sale, repairs and maintenance, tires, and bicycle construction—amounts to about 1,300 Btu/mile. The comparable figure for urban automobile travel is 11,000 Btu/passenger-mile for trips of five miles or less. Thus a shift from cars to bicycles would save about 10,000 Btu/passenger-mile, a 90% reduction from the energy use for automobiles. If 10% of the urban auto travel conducted during daylight and in good weather for trips of five miles or less was shifted to bicycles, the savings in 1971 would have been 160 trillion Btu, 1.6% of total urban automobile energy use. (auth)

N74-208144 New York State Office of Economic Research.

Abstract. CONSUMPTION OF ENERGY IN NEW YORK STATE: 1922 (WITH ESTIMATES FOR 1973) Oef Neugast Jan. 1974 32 p refs Supplement to OER-10 Supercedes OER-15

(OER-19; OER-10-Suppl; AER-15) Avail: NTIS HC \$4.76 Revisions in the 1971 consumption data for fossil fuels reveal that energy consumption in New York State in 1971 was 4,239.3 T-BTU, a drop of 53.6 T-BTU from 1970 (-1.2%). The decline was a result of an unprecedented drop in fossil fuel demand by the industrial section from 577.6 T-BTU in 1970 to 455.4 T-BTU in 1971. In 1972 the industrial sector consumed 414.8 T-BTU from fossil fuels, a decline of 8.9% from the 1971 level. During both 1971 and 1972 the other three major energy consuming sectors continued their upward trend in energy consumption. Author

N74-17686# Bureau of Mines, Washington, D.C. Office of Economic Analysis. DETERMINING THE EFFECTS OF GASOLINE PRICE ON USE OF METALS IN AUTOMOBILE MANUFACTURE Philip N. Yasnowsky and Donald S. Cobby 1974 18 p refs (BM-R1-7871) Avail: NTIS HC \$4.00 An attempt was made to relate the size of automobiles to the price of gasoline, and the use of minerals in automobile manufacture to the size of automobiles. Only one of the many plausible scenarios of public reaction to higher gasoline prices, a switch to economy size automobiles, is developed. No account is taken of other potential impacts such as improvements in public transportation or increased occupancy per vehicle. Furthermore, a gasoline price increase is the only incentive to the greater utilization of economy cars that is considered. A gasoline price increase to \$0.60 per gallon would reduce the amount of minerals required to produce the automobiles sold in the United States by an estimated 15 percent. Gasoline prices of \$0.80 and \$1 per gallon would cause declines in mineral requirements for U.S. automobile sales estimated at 26 percent and 35 percent, respectively. Author

FOOD-RELATED ENERGY REQUIREMENTS.

E. Hirst. Science, v.184, Apr.12,1974, p.134-138.

The energy used by the U.S. food cycle constitutes about 12 percent of the national energy budget.

ENERGY REPORT/STUDY LISTS INDUSTRIES BY ENERGY INTENSIVENESS.

T.B. Clark. Nat. Jour. Repts., 3/2/74, p.328-330.

Business categories are ranked according to energy costs as a percentage of value of shipments. The compilation was assembled from the Commerce Dept. 1971 survey of manufacturers.

1974

ENERGY AND THE CAPITAL MARKETS. Saul, R. B.
Pub. Util. Fortn.: 93: No. 3, 33-38(3) Jan 1974).

The urgency for the search for new sources of capital and lower costs of financing for the investor-owned utilities is discussed. The external financing requirements of the electric utilities will jump from \$10 billion in 1973 to \$14 billion in 1977. Utility financing is now more complex. Utilities may have to finance nuclear fuel cores, coal mines, pipelines, storage terminals, and ships, as well as equipment to control pollution connected with utilities. The maintenance of current earnings levels will be a function of rate relief and this is the only solution to the industry's ability to raise equity capital. (MCW)

Science, v.184, no.4134, Apr. 19, 1974

ECONOMICS

Energy Use in the U.S. Food System: J. S. Steinbart and C. E. Steinbart	307
Economic Strategy for Import-Export Controls on Energy Materials: H. J. Frank	316
Oil Money and World Money: Conflict or Confluence?: T. R. Stanger	321
Applications of Input-Output Analysis to Energy Problems: A. P. Carter	325

Theory and Practice of Electricity Pricing in the United States.
Raden Mas Sunardi.
Naval Postgraduate School Monterey Calif Mar 74. 116p
AD-776 279/2WE PCS9.00/MF\$1.45

The paper is a study of the current state of the art, in both the theory and actual practice, of electricity pricing in the United States under capacity and revenue constraints. It is also an attempt to derive an efficient pricing policy that will be applied to large Government installations. A mathematical formulation of electricity pricing using two different approaches is presented. (Modified author abstract)

1974

Concentration Levels and Trends in the Energy Sector of the U.S. Economy. Economic Report. A Staff Report to the Federal Trade Commission.
Joseph P. Mulholland, and Douglas W. Webbink.
Federal Trade Commission, Washington, D.C. Bureau of Economics. Mar 74. 510p. FIC-R-6-15-20
PB-230 035/3WE PCS10.00/MF\$1.45

The report is a sequel to Interfuel Substitutability and addresses itself to the interrelationship between interfuel merger activity and seller concentration within the primary fuel production sector. The present study investigates ownership structure from the point of view of an aggregate fuel supply sector. All fuel production is combined in order to obtain a meaningful measure of seller concentration which can in turn be used as one indicator of the competitive condition of the energy market and the extent to which it has been affected by the movement toward energy companies. It contains a survey of the interrelationships between the four primary fuels as well as a discussion of the potential effects of rising energy diversification on performance within the energy sector. The report surveys the ownership structure as well as pertinent institutional details of the crude oil, natural gas, coal and uranium sectors, respectively, and analyzes ownership patterns within the combined fuel production market and the extent to which they have been altered by recent interfuel diversification activity.

K-140,629
Hitman Associates, Inc.
Contract No. MSF-C674

THE AUTOMOBILE ENERGY AND THE ENVIRONMENT. A TECHNOLOGY ASSESSMENT OF ADVANCED AUTOMOTIVE PROPULSION SYSTEMS. Douglas G. Harvey and W. Robert Menden. March 1974.

ENERGY: GONE TODAY HERE TOMORROW?
A Report to the SAE Board of Directors.
P.S. Meyers, et al.
Automotive Engineering, v.82, no.5, May 1974,
p.68-71,83,85,87,89,91,93,95,101.

SAE Ad Hoc Committee on Energy and Transportation report which assesses the key limitations likely to be imposed on the form and use of energy for transportation; specifies the key scientific and technological actions necessary to meet these limitations and delineates the steps to be taken by SAE to assist and participate in these actions.

1974

Energy Self-Sufficiency: An Economic Evaluation

Policy Study Group of the M.I.T. Energy Laboratory:
 Morris A. Adelman, Robert E. Hall,
 Kent F. Hansen, J. Herbert Hollo-
 mon, Henry D. Jacoby, Paul L. Jos-
 kow, Paul W. MacAvoy, Herman P.
 Meissner, David C. White, and Mar-
 tin B. Zimmerman

Energy independence by 1980 is insur-
 ance against disruption or price increase
 that will be purchased at very high cost.
 There may be other ways of assuring the
 nation's supplies and security

Summary of the Study	25
1: The Critical Uncertainties	26
2: Energy Supply and Demand in 1980	27
3: The Supply of Domestic Petroleum	32
4: The Supply of Natural Gas	35
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8: The U.S. and the World Oil Market	47
9: Policy Conclusions	53
Appendix: The Origin of Synthetic Fuel Costs	56

Energy: Direct and Indirect Energy Requirements for Automobiles
 Comparative report: Oak Ridge National Laboratory, ORNL-452 Environmental Progress Report No. 37630
 ADDRESS: P.O. Box 2, Oak Ridge, TN 37830
 PUBLICATION DESCRIPTION: Report No.
 ORNL-452-EP-64, 38 p., 26 references
 PUBLICATION DATE: 1974, February
 SPONSOR: National Science Foundation, RARE Program
 ABSTRACT: Variations in automobile fuel use as a function of trip length and of driving conditions (urban and inter-city) are calculated for three hypothetical and automobiles: subcompact, "average," and full-size. In addition to direct (propulsion) energy use, total energy requirements for these three cars, operated under both urban and inter-city driving conditions, are calculated. Fuel use declines markedly with increasing trip length, because the adverse impacts of cold-start are spread over more miles. Fuel use is considerably higher for urban driving than for inter-city driving, because of frequent stop-and-go cycles and cold-start operations (due to shorter trip lengths for urban driving). Subcompact use such less fuel than do full-size cars, particularly in urban areas. Total energy requirements for cities exceed direct gasoline consumption by about 70%. (author)

Availability: See Fuel Econ. 84(4), 3580, ORNL, P.O. Box 1, Oak Ridge, TN 37830

Mature, v.249, June 21, 1974, p.715-717. Making energy value for money

W. Short

NIFES Consulting Engineers, NIFES House, Sinderland Road, Broadbeath, Altrincham, Cheshire WA14 5HQ, UK

The National Industrial Fuel Efficiency Service Ltd, once a British Government body but now a successful private company, pays close attention to an energy problem that is often ignored.

AGRI-BUSINESS AND ENERGY USE.

Data sheet available for 15 cents per copy
from the League of Women Voters Education
Fund, 1730 N. St., N.W., Wash., D.C. 20036.

FUEL AND THE U.S. AEROSPACE INDUSTRY.

P. Geddes.
Interavia, v.29, Mar.1974, p.245-6.

THE ECONOMICS OF THE ENERGY CRISIS.

P.W. McCavoy, P.A. Samuelson, and L.C. Thurrow.
Tech. Rev., Mar./Apr.1974, v.76, no.5, p.49-59.

Three economists consider the impact of higher
prices and decreasing availability of energy.

ENERGY USE IN THE U. S. FOOD SYSTEM. Sam-
hart, J. B. (Unit. of Wisconsin, Madison; Sauerbrey, C. E.
Science, 184: No. 4124, 267-269(19 Aug 1974).
An investigation into the growth of energy use in the food system
is presented. An attempt is made to compare the present food sup-
ply system, in energy measured, with those of other societies and
with the U. S. past. The energy provided by the sun is omitted in
the survey, but the other factors considered are fuel (direct use),
electricity, fertilizer, agricultural steel, farm machinery, tractor,
irrigation, food processing industry and machinery, paper packag-
ing, glass containers, steel cans and aluminum, transport (fuel),
trucks and trailers, commercial refrigeration and cooling, refriger-
ation machinery (home and Commercial), home refrigeration and
cooling. Private delivery by the individual is not included. Energy
subsidies for various food crops are shown in various countries
and compared with the U. S. food system. In primitive cultures, 5
to 50 food calories were obtained for each calorie of energy in-
vested. Industrialized food systems require 5 to 10 calories to ob-
tain 1 food calorie. An analysis of the energy flow in the food sys-
tem illustrates features of the food system unrealized in a usual
economic analysis. (22 references) (RCV)

ENERGY AND THE PETROCHEMICAL INDUSTRY.

V.L. Gregory.
Chem. Eng. Prog., v.70, no.5, May 1974,
p.26-29.

Chemical companies should have access to raw
materials wherever available, including OPEC
countries; it doesn't mean the world chemical
industry will pack up and move to the Middle
East.

Environment & Change, v.2, no.5, Jan.1974.

ENERGY CONSUMPTION AND

ENERGETIC GROWTH

Our Special Correspondent

The growth of energy consumption in advanced
societies in recent decades has been closely linked with
economic growth. But the past half century has also
seen a marked decline in the energy intensiveness of
industrialized communities, partly because of the grow-
ing importance of the service industries.

N74-19624# Mitre Corp. McLean, Va. Transportation Systems Engineering Dept.
US TRANSPORTATION: SOME ENERGY AND ENVIRONMENTAL CONSIDERATIONS
 W. E. Fraize Sep. 1974 49 p refs
 (M72-164) Avail: NTIS HC \$5.50

The role of transportation in air pollution and consumption of energy, especially petroleum, is reviewed, with emphasis on the U. S. situation. Both technological and control measures for each problem area are discussed. Technological measures focus on the automobile, high speed ground transportation modes, and non-petroleum fuels, while control measures, which encourage the use of the more efficient transportation modes, are seen to offer significant benefits. The near future is discussed with respect to the impact of the U. S. Amended Clean Air Act of 1970. Transportation evolution over the next few decades is projected.
 Author

N74-20622# RAND Corp., Santa Monica, Calif.
COPING WITH THE FUEL SHORTAGE: A GUIDE FOR LOS ANGELES RESIDENTS
 M. H. Graubard and J. J. Much Jan. 1974 23 p
 (P-5154) Avail: NTIS HC \$4.25

Energy uses and conservation measures for the Los Angeles. California area are outlined. Charts are presented which show: the consumption rates for different household appliances; the sources of energy; and consumption of energy by automobiles. Measures for voluntary energy conservation among residents are outlined along with an emergency plan for electric utilities.
 S.K.W.

Residential Energy Consumption, Multifamily Housing.
 Melin Lokmanhekin, and Douglas G. Harvey.
 Hitman Associates, Inc., Columbia, Md. Jun 74, 179p
 HUD-HAI-4
 PB-232 637/9WE PC\$5.50/MF\$1.45

Energy utilization of typical multifamily residences (i.e., townhouse, low-rise and high-rise apartments) located in the Baltimore-Washington area were studied in detail, and the results of a parametric study which defines improved energy consuming residences were presented.

(ONNL-NSF-EP-66) **TOTAL ENERGY USE FOR COMMERCIAL AVIATION IN THE U. S.** Hirth, E. (Oak Ridge National Lab., Tenn. (ORNL). Apr 1974. Contract W-7408-eng-26. 15p. Dep. NTIS \$4.90.

The total energy impacts of commercial aviation in the United States are shown. Direct fuel use by commercial airplanes (1650 trillion Btu in 1971) amounts to 6% of direct fuel use for all domestic transportation, 1.6% of the total national energy budget. Indirect energy requirements are one-third as great as the direct aviation in 1971 was 1450 trillion Btu, 2% of national energy use. Direct fuel savings due to adoption of airline conservation measures can be increased by one-third to account for the indirect energy savings. Some conservation measures, such as a reduction in short-haul flights, are likely to have larger energy savings, because short-haul flights involve higher maintenance costs, greater airport use, and higher passenger service costs on a passenger-mile basis than do longer flights. Other measures, such as reducing cruise speeds, are likely to have relatively small indirect energy savings. In all cases, however, the direct fuel savings can be increased by 20% to account for the energy costs associated with crude oil extraction, transportation, and refining.
 (HC74)

1972 UTILITY STATISTICS: Financial and operating data compiled by the Federal Power Commission for 623 publicly-owned utilities. (Order No. S-325, available at \$1.95 from Superintendent of Documents, Government Printing Office, Wash., D.C. 20402.)

N74-12676* Auburn Univ., Ala.
ENERGY AND RESOURCE CONSUMPTION
In its TERASTAR. Terrast. Appl. of Solar Technol. and Res.
 Sep. 1973 10 p refs (For availability see N74-12674 03-34)
 CSC1.20M

The present and projected energy requirements for the United States are discussed. The energy consumption and demand sectors are divided into the categories: residential and commercial, transportation, and industrial and electrical generation (utilities). All sectors except electrical generation use varying amounts of fossil fuel resources for non-energy purposes. The highest percentage of non-energy use by sector is industrial with 71.3 percent. The household and commercial sector uses 28.4 percent, and transportation about 0.3 percent. Graphs are developed to project fossil fuel demands for non-energy purposes and the percentage of the total fossil fuel used for non-energy needs.
 Author

SOCIAL, ECONOMIC, AND UTILITY GROWTH. Garvin, D. F. (Ebasco Services, Inc., New York). Pub. Util. Forum; 91: No. 4, 23-38 (15 Feb 1973).

Social planning and social engineering are advancing in the nation today with little thought given to the economics involved. The ability of the USA to meet its future energy needs will be determined chiefly by the developments in technology—the technology of conversion and the technology of fuels acquisition. Utilization of the resources available is a costly problem. Their conversion into the stream of the economic and social life by means of capital, energy, labor, and efficient use also involves the rate of growth and total population. A report is given of electric companies' construction data, rate actions, and capacity. (CW)

An Energy Input-Output Matrix for the United States, 1963: User's Guide.

Robert A. Herendeen.
 Illinois Univ., Urbana. Center for Advanced Computation. 4 Mar. 73. 99p CAC-69. NSF-RA/N-73-034
 PB-227 872/9WE. PC\$8.00/MF\$1.45

Input-Output analysis offers a theoretical framework and large data base well suited to calculating the total (direct and indirect) energy cost of many classes of products (both goods and services). The paper discusses conversion of the 1963 Input-Output table to energy terms at the 352 sector level. The methodology is described in detail, and potential sources of error are discussed. Several applications are presented: (1) detailed breakdown of the contributors of the total energy cost, (2) total energy efficiency of the energy-producing sectors, (3) energy required by agriculture, the food industry, and the energy cost of protein, (4) energy required by a small appliance, an electric mixer. (Author)

N74-16685# Yale Univ., New Haven, Conn. Cowles Foundation for Research in Economics.
SOME OBSERVATIONS ON OPTIMAL ECONOMIC GROWTH AND EXHAUSTIBLE RESOURCES
 Tjalling C. Koopmans 1973 18 p refs Sponsored by NSF and Ford Found.

(Cowles Foundation Paper 396) Avail: NTIS HC \$3.00
 The optimal paths of trading for an exhaustible resource model are compared in terms of consumption. The optimal rate of utilization of exhaustible resources, and the theory of optimum capital growth are discussed. It is concluded that the combination of discounting of future utilities at a positive rate, and the costless storage in nature of the resource prior to extraction leads to an exponential increase in the scarcity price of the resource. F.O.S.

73-WA-289-4 ■ **Attitudes and Energy Demand.** by R. A. Herendeen, University of Illinois, Urbana, Ill.

The dependence of total energy impact of consumer spending on income is investigated for the period 1960-1963. Total energy impact denotes all energy consumed along the chain of mining—manufacturing—sales. The methodology involves combining detailed consumer expenditure data and appropriate energy conversion coefficients from Input-Output analysis.

It is found that the slope of total energy impact versus income decreases somewhat at higher incomes. This is due to a leveling off of direct energy demand (that resulting from residential heating, lighting, etc., and fuel for the automobile). Indirect energy demands (due to all other expenditures) show a linear dependence on income.

For the lowest income class (\$1246/yr after taxes), direct energy demand produces two-thirds of the total energy impact, while for the highest income class (\$20511/yr after taxes), direct energy demand produces only one-third of the total. Implications for energy conservation measures are discussed.

Paper presented at the ASME Winter Annual Meeting, Nov. 11-15, 1973, is available to Aug. 1974.

1973

IMPACT OF THE MOTOR CAR ON OIL RESERVES.

Leach, G. (Univ. of Sussex, Brighton, Eng.). Energy Policy; i. No. 3, 195-207 (Dec 1973).

Road vehicles, and particularly the car, consume substantial shares of the world's oil resources, though they do not account for a very significant proportion of total energy consumption. In 1970 the world car fleet took 12% of global oil consumption or 6% of gross energy consumption. Other road vehicles took nearly the same again: 9% of world oil and 4.5% of total energy. The USA car fleet, with 48% of the vehicles, accounted for 65% of the oil consumption of the world car fleet. Forecasts indicate a large world car population growth. The question is studied of how governments and communities will act in this situation. If they continue to permit the private motorist unfettered freedom to own cars with extravagant fuel consumption, the growing demands of motoring are certain to accelerate the exploitation of the world's dwindling oil reserves and raise prices. It will merely postpone the problem of depleting oil supplies. Alternatives are discussed and include encouragement of public transport systems, smaller cars, development of batteries and conversion of organic wastes, and rails and waterways for freight transport. (MCW)

1973

Effect of Speed on Automobile Gasoline Consumption Rates

AUTHOR: Cope, R.H.
CORPORATE AUTHOR: U.S. Dept. of Transportation,
Federal Highway Administration, Office of
Highway Planning, Highway Statistics Division
1994551: 400 Seventh St. SE, Washington, DC 20591
PUBLICATION DESCRIPTION: 8 p. report
PUBLICATION DATE: 1973, October

ABSTRACT: The purpose of this study was to measure, under practical operating conditions, the effect of automobile speed on gasoline consumption. Twelve cars with weights varying from 2050 lbs. to 5250 lbs. were used for the tests. The testing methods and equipment are described, and data are presented for each car on miles per gallon at 30, 40, 50, 60, and 70 miles per hour, and the percent increase in gasoline consumption caused by increases in speed from 30 to 40, 40 to 50, 50 to 60, 60 to 70, and 40 to 70 miles per hour. Measurements were made with and without the use of air conditioning, and the fuel consumption of one car was measured before and after tuning. When the results from the 12 cars were averaged, it was found that fuel economy decreased from 21.05 miles per gallon at 30 mph to 16.03 at 70 mph without the use of air conditioning, and from 18.18 to 13.17 with air conditioning. The use of air conditioning reduced the average car's mileage by as much as 2 miles per gallon, and a tune up improved the mileage of one car by better than 2 miles per gallon. (HWC)
AVAILABILITY: U.S. Dept. of Transportation (no charge)

1973

Total Energy Demand for Automobiles

AUTHOR: Hirst, P. J. W. (University of Cambridge, U.K.).
CORPORATE AUTHOR: Oak Ridge National Laboratory,
Operational Research Program, 111000.

UNIVERSITY OF CAMBRIDGE, Center for Advanced Computation
PUBLICATION DESCRIPTION: Paper to be presented at the Society of Automotive Engineers International Automotive Engineering Congress and Exposition, Detroit, January, 1973, 22 p.
PUBLICATION DATE: 1972, January

SPONSOR: National Science Foundation

ABSTRACT: Automobiles in the United States consumed about 66 billion gallons of gasoline in 1970, with an energy content of 8,900 trillion Btu. Two-thirds of this fuel was devoted to urban travel, the remaining one-third to inter-city driving. This automobile gasoline consumption accounted for 5% of the total U.S. transportation energy budget. Direct consumption of gasoline by autos is only part of the automotive energy picture. Indirectly--to manufacture, sell, maintain, repair, insure, refine petroleum, and build highways for it--the automobile consumes about three-fifths as much energy as it does directly in gasoline, approximately 5,500 trillion Btu in 1970. Including both direct and indirect energy, the auto consumed 16,00 Btu/vehicle-mile that year. This is equal to 21% of the total U.S. energy budget. (HWH)

1973

ENERGY COST OF GOODS AND SERVICES

AUTHOR: Hirst, P. J. W. (Oak Ridge National Lab., Tenn.).
CORPORATE AUTHOR: Oak Ridge National Lab.,
Operational Research Program, 111000.
PUBLICATION DATE: 1973, October

ABSTRACT: The 1963 Input-Output Table (U.S. Department of Commerce) was converted to energy terms. The results facilitate calculation of the total energy cost of many consumer goods and services. Total energy cost denotes all energy inputs in the manufacture, sales chain, including extraction of raw materials, primary processing, transportation, intermediate and final fabrication, and final marketing activities. A 362 sector breakdown has been used, and 5 energy sectors are included (coal, crude oil and gas extraction, refined petroleum, electricity, and gas sales). Results are in the form of coefficients which transform dollar expenditures in the 362 sectors into energy impact. The methodology of the conversion is described in detail; basically, it involves combining detailed energy pricing data with existing dollar sales data. Potential shortcomings are discussed; many are inherent to the input-output approach itself. It is hoped that the results will be useful in many applications. Four are presented here: a method to obtain a detailed breakdown of the energy to make a product; e.g., the energy needed to make the glass, steel, rubber, etc., contained in an automobile; a calculation of the total energy impact of the private auto in 1963, in which the many auto-associated expenditures are assigned an appropriate energy cost; a calculation of the energy-efficiency of the energy sectors in providing energy to final demand; and a calculation of the energy cost of a kitchen electric mixer. (auth)

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74NT2922# PB-224146/1GA 73/05/00 144 PAGES UNCLASSIFIED DOCUMENT
 OREGON'S ENERGY PERSPECTIVES FINAL REPORT, JAN. - MAY 1973
 OREGON STATE EXECUTIVE DEPT., SALEM. AVAIL. N.T.S.
 /*CONSERVATION/*ENERGY CONSUMPTION/*ENERGY REQUIREMENTS/*OREGON/
 ENERGY SOURCES/ POLICIES

74NT2846# PB-224853/2GA MEL-TR-87 73/06/00 19 PAGES UNCLASSIFIED
 DOCUMENT
 AN ECONOMIC INTERPRETATION OF THE ENERGY GNP RATIO
 A/BERNCT, E. R.; B/MCOD, D. C.
 MATHEMATICS AND COMPUTATION LAB., MCLEAN, VA. AVAIL. N.T.S.
 /*ECONOMIC ANALYSIS/*ENERGY/*PRODUCTION ENGINEERING/ ENERGY
 CONSUMPTION/ PARTIAL DIFFERENTIAL EQUATIONS

1973

1973

N74-16673# RAND CORP. Santa Monica, Calif.
 A METHODOLOGY FOR PROJECTING THE ELECTRICAL
 ENERGY DEMAND OF THE COMMERCIAL SECTOR IN
 CALIFORNIA
 W. E. Moor and C. C. Mow Mar. 1973 48 p refs
 (Grant NSF G1-44)
 (R-1106-NSF/CSRA) Avail: NTIS HC \$4.50.
 Methodology was developed for the electrical energy demand
 of commercial sectors, missing portion of the industrial sector,
 and other small sectors of California economy. Methodologies
 were based upon the output of the sector, measured in terms
 of dollars of value added or dollars of contribution to gross state
 product; on the electrical energy intensiveness of the sector;
 and upon the price of electricity and natural gas. In small sectors,
 such as agriculture and railroads, the use of electricity was found
 to be either constant or the result of fairly simple forces. J.A.M.

N74-16673# RAND CORP. Santa Monica, Calif.
 A METHODOLOGY FOR PROJECTING THE ELECTRICAL
 ENERGY DEMAND OF THE MANUFACTURING SECTOR
 IN CALIFORNIA
 W. E. Moor and C. C. Mow Jan. 1973 75 p refs
 (Grant NSF G1-44)
 (R-991-NSF/CSRA) Avail: NTIS HC \$5.75
 The methodology reported is one part of a total electrical
 energy demand estimating methodology developed for use in
 California. Separate methodologies were developed for each sector
 of the economy, which comprises the following: residential;
 industrial (consisting of manufacturing and mining); commercial;
 governmental; and agricultural. In place of quantitative, determin-
 ant-based relationships, the methodology described relies on the
 projection of individual trends in electrical energy use for each
 of 20 manufacturing industries identified by the Standard Industrial
 Code. Data on these trends are presented, and reasonable
 projections are suggested. In addition, the roles of each of the
 determinants of electrical energy use are explained qualitatively
 for the benefit of analysts required to apply judgment in selecting
 inputs for the methodology. Author

ENERGY COST OF AUTOMOBILES. Berry, R. S.; Pula, M. F. (Univ. of Chicago). Bull. At. Sci.: 30: No. 10, 11-17, 35-60 (Dec 1973).

One of the consequences of the energy crisis has been a heightened interest in the amounts of energy we use for industrial processes. A conspicuous one is the manufacture of automobiles. The total free energy consumed in manufacture of a 1967 auto is ~37,275 kWh. The immediate purpose of the study was to provide the Institute of Environmental Quality of State of Illinois with assistance in making decisions on the disposal of automobile hulks and of solid waste in general. In a larger context, the analysis examines one aspect of how we use materials and energy from a thermodynamic point of view. The study is a pioneering effort in a new field of energy analysis. Its significance is illustrated by only one of its conclusions—that recycling junked autos that scuttly our landscape and reducing the scrap in the manufacture of new ones would achieve dramatic reductions in total power consumption. (MCF)

ENERGY CRISIS AND TRANSPORTATION.
J.G. Winger. p.38,39.

THE ENERGY CRISIS: ALTERNATIVES FOR TRANSPORTATION.
P.40-44.

SAE Automotive Engineering, v.81, no.3, Mar.1973.

**N74-17781# RAND Corp. Santa Monica, Calif.
ENERGY TRENDS AND THEIR FUTURE EFFECTS UPON
TRANSPORTATION**
W. E. Mooz. Jnl. NTIS 27 p. refs
(P-8046) Avail: NTIS HC \$3.50

The impact of fuel shortages on the transportation energy is discussed. The areas investigated are: (1) the demand for energy for transportation purposes, (2) the supply of energy for transportation purposes, and (3) the expected price of energy. Graphs are included to show the overall energy requirements, comparative energy intensiveness values for different methods of transportation, recent trends in automobile fuel use, a history of rail, truck, and air cargo development, and an analysis of annual energy consumed by all transport modes in the United States. P.N.F.

A74-19486 # The implications for air transportation of energy shortage. L. A. Mountford and R. E. Williams (Shell International Petroleum Co., Ltd., London, England). *Istituto Internazionale delle Comunicazioni, Convegno Internazionale delle Comunicazioni*, 21st, Genoa, Italy, Oct 8-13, 1973. Paper. 25 p.

After referring to the enormous increase in air transport during the last twenty years, encouraged by the considerable availability of low cost fuel, the authors discuss the problems and difficulties which may in the near future affect the aviation market's oil supplies. The more demanding quality requirements and the ever growing needs of light distillates by all the other markets are taken into consideration. Attention is given, moreover, to the possibilities open to the oil companies, aircraft manufacturers, and airline operators in order to moderate and alleviate this critical situation. (Author)

**N73-33921# RAND Corp. Santa Monica, Calif.
GROWTH RATES WITHIN THE TRANSPORTATION SECTOR**
W. E. Mooz. Jan. 1973. 10 p. Presented at San. on Energy as a Scarce Resource, Pasadena, Calif., 9 Dec. 1972; sponsored by Environ. Qual. Lab., the Sierra Club, and League of Women Voters
(P-49835) Avail: NTIS HC \$3.00

Report is made of an investigation into the nature of transportation in terms of energy depletion and fuel consumption. Graphic profiles are presented which trace the growth rates of specific modes of passenger and freight transportation from 1865 to 1968. A summary of likely transportation energy demands for the future is also included. J.M.M.

**N73-33921# RAND Corp. Santa Monica, Calif.
TRANSPORTATION AND ENERGY**
W. E. Mooz. Jun. 1973. 23 p. refs. Presented at the 1st Annual Illinois Energy Conf., Chicago, 13-15 Jun. 1973
(Grant NSF-GI-44)
(P-5025) Avail: NTIS HC \$3.25 CSCL 21D

The use of energy in the transportation sector is discussed. Transportation in the United States presently uses about 25 percent of the total annual energy budget, and the use of energy in the sector is increasing at an average annual rate of about 4 percent per year. Over 95 percent of this energy is supplied by petroleum fuels, and the biggest users are motor vehicles. Differences in model efficiencies are shown, with motor vehicles, aircraft the least efficient energy users. The growth in energy use by transportation is shown to be due to increasing model use by transportation, shifts in traffic from low intensiveness modes to high intensiveness modes, and increasing per capita use of transportation. One may expect to see more small cars, shifts from air and highway modes to buses, trains, and pipelines, and changes in personal transportation habits. Author

1973

B74-18607# RAND Corp. Santa Monica, Calif.
TRANSPORTATION ENERGY USE IN THE UNITED STATES:
A STATISTICAL HISTORY, 1966 - 1971
James J. Much Dec. 1973 54 p refs
(Grant NSF G1-44)
(R-1391-NSF) Avail: NTIS HC \$5.75

Transportation energy consumption is considered in view of increased travel per person and an increasing use of more energy intensive modes. Energy distribution for modes and markets is shown from 55 to 71 in graphical form. Freight and passenger transportation on highways, aircraft, railroads, and waterways are also reviewed.
J.A.M.

A74-19479 # Energy problems in air transportation. G. E. Lundquist (FAA, Washington, D.C.), *Istituto Internazionale delle Comunicazioni, Convegno Internazionale delle Comunicazioni*, 21st, Genoa, Italy, Oct. 8-13, 1973, Paper, 25 p, 9 refs.

Energy development and usage are worldwide problems. The prospects of energy supply and demand over the long term indicate a critical impact on air transportation. Unless energy is conserved through various alternative actions, air transportation will suffer. This paper analyzes options for reducing demand, for improving efficiency, and for diversifying, both through alternative fuels and transportation modes, for the near term (one to 15 years) and the 15-year plus time frame. These options offer a 30 to 50% reduction in projected fuel requirements.
(Author)

74-19479 # Energy problems in air transportation. G. E. Lundquist (FAA, Washington, D.C.), *Istituto Internazionale delle Comunicazioni, Convegno Internazionale delle Comunicazioni*, 21st, Genoa, Italy, Oct. 8-13, 1973, Paper, 25 p, 9 refs.
Publication description: Report no.
Publication date: 1973, May
Sponsor: U.S. Dept. of Transportation, Office of the Secretary
Abstract: The implications of a reduction in petroleum products for transportation use are investigated in this report. Criteria are set forth for developing an optimum allocation or rationing plan. The impact on air of illustrative alternative rationing plans is estimated for petroleum products of 10 percent and 36 percent. (auth)

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Intersociety Energy Conversion Engineering Conference, 8th Philadelphia, Pa., 1973.
Proceedings. New York, American Institute of Aeronautics and Astronautics [1973]
847 p. illus. 29 cm.
Held at: University of Pennsylvania, Philadelphia, Pa., August 13-16, 1973.
Sponsored by: American Institute of Aeronautics and Astronautics [and others]

Passenger Car Design Influences on Fuel Consumption and Emissions
L. L. AMBS.....
A Comparative Study of Residential Energy Usage - F. O. CALVERT,
D. G. HARDEN.....

Passenger Car Design Influences on Fuel Consumption and Emissions
L. L. AMBS.....
A Comparative Study of Residential Energy Usage - F. O. CALVERT,
D. G. HARDEN.....

TRANSPORTATION ENERGY USE AND CONSERVATION POTENTIAL. Hirst, E. (Oak Ridge National Lab., TN).
Bull. At. Sci.; 29: No. 9, 36-42(Nov 1973).

Traffic, energy consumption, and energy intensiveness for inter-city freight and passenger traffic and urban passenger traffic are discussed. Transportation of people and goods consumes one-fourth of the total U. S. energy budget. Ninety percent of the world oil supply will have been consumed by about 2025 and ninety percent of U. S. oil reserves within 30 years. U. S. transportation is almost entirely dependent on oil as a fuel. Exploration, production, transportation, refining, and use of petroleum present serious environmental problems. Transportation contributes to a number of other environmental problems including urban congestion, inefficient land use, and noise. These facts support the urgent need for an examination of transportation energy use. (MCW)

74-WA/Engr-4 # Energy Conservation by the Transportation Industry, by Sergio Granich, Fellow Mem. ASME, Ford Motor Company, Dearborn, Mich.

Immediate causes of the current fuel shortage in transportation include: (a) the absence of a rational, cohesive energy policy in the past, (b) a tradition of ready availability of low-cost energy, (c) environmental pressures, and (d) government regulations on safety and damageability.

Many solutions which have been proposed for the transportation energy problem are either unrealistic or too long-range for the immediate crisis. This paper discusses short-range approaches, intermediate-term solutions, and long-term solutions.

Paper presented at the ASME Winter Annual Meeting, Nov. 11-15, 1973, available to Aug. 1974.

Year	Total (10 ¹² Btu)	Petroleum Supply from Imports (%)	Petroleum Supply Used in Trans- portation (%)	Transportation Energy from Petroleum (%)
1950	13,489	10.6	50.3	77.8
1955	17,524	11.5	52.0	92.0
1960	20,067	17.8	51.7	95.3
1965	23,241	21.4	52.5	95.5
1970	29,617	22.2	53.2	95.5

73-WA/Ener-4 Petroleum consumption in the U. S. (E. H. W. Report ORNL-NSF-EP-15.) This expected shortfall of domestic sources represents a critical problem for the transportation industry, which is almost totally dependent on petroleum as an energy source. In 1970, it has been estimated that 95.5 percent of the energy for transportation was obtained from petroleum. Paper presented at the ASME Winter Annual Meeting, Nov. 11-15, 1973.

1973

1973

(CONF-730305-2) RESIDENTIAL DEMAND FOR ELECTRICITY. Tansil, J.; Moyers, J. C. (Oak Ridge National Lab., Tenn.). 1973. 17p. Dep. NTIS.

From Conference on energy, demand, conservation, and institutional problems; Cambridge, Massachusetts, USA (12 Feb 1973). The growth of residential electricity use for the period 1950 to 1970 is examined from the standpoint of increases in the number of households, appliance saturations, and the average annual electricity consumption per appliance. Growth patterns defined illustrate the factors accounting for the increase from 1800 kWh per household in 1950 to 7000 kWh per household in 1970. Space heating, water heating, and air conditioning have small saturations, large average annual consumptions, and the greatest growth potentials for contributing to the residential load. Energy conservation is stressed through (1) the importance of housing insulation, (2) more efficient room air conditioners, and (3) the substitution of heat pumps for electric resistance heating. The number of households, appliance saturations, and average annual electricity use per appliance are projected to 1990 to obtain the total electricity consumption per appliance. The sum of the disaggregated projections is compared to other independent projections based on extrapolation and econometric methods. (auth)

N74-13675 National Research Council of Canada, Ottawa (Ontario). Engine Lab. ENERGY IN TRANSPORTATION E. P. Cockburn. In: *Quarterly of the Div. of Mech. Eng. and the Natl. Aeron. Estab.* 30 Sep. 1973 p 25-32 refs (For availability see N74-13673 04-34)

The energy requirements of a variety of transportation systems are reviewed in the context of the current concern over diminishing resources of hydrocarbon fuels. The energy costs of current passenger and cargo transportation systems are presented. The energy cost components - thermo-propulsive efficiency, frictional resistance, and structural efficiency - are assembled as a ratio for low energy cost. Charts and graphs are included. K.M.M.

N74-16689 RAND Corp., Santa Monica, Calif. RESIDENTIAL ENERGY USE: AN ECONOMETRIC ANALYSIS. Kent P. Anderson. Oct. 1973 60 p refs (Grant NSF GI-44) (R-1297-NSF) Avail: NTIS HC \$6.50 The demands of the residential sector of the U.S. economy for energy resources in the form of gas and electricity are discussed. Tables of data are presented to show the various predictions concerning the future price of electricity and natural gas to the consumer. Methods for predicting the future cost of energy resources are explained. The energy requirements for residential use are expressed in mathematical models and the results are tabulated for type of fuel, type of home, and specific uses within the home. Author

(ORNL-NSF-EP-81) RESIDENTIAL CONSUMPTION OF ELECTRICITY, 1950-1970. Tansil, J. (Oak Ridge National Lab., Tenn.). Jul 1973. Contract W-7405-eng-38. 35p. Dep. NTIS \$3.75.

The growth of residential electricity use between 1950 and 1970 is examined on the basis of increases in the number of households, number of appliances, and the average annual electricity consumption per appliance. Increased electricity use per household accounted for 73% of the growth of residential electricity consumption, while 27% of the growth was due to an increase in the number of households. Consumption patterns are defined that illustrate the factors accounting for the increase from 1800 kWh per household in 1950 to 7000 kWh per household in 1970. The greatest potential for more efficient energy use occurs through insulating houses better, shifting from electric resistance heating to heat pumps, using more efficient air conditioners, substituting fluorescent for incandescent lighting, and improving insulation for refrigerators, freezers, and water heaters. Immediate implementation of these energy conservation measures would result in a 30 to 40% reduction in residential electricity consumption. The number of households, number of appliances, and average annual electricity use per appliance are projected to 1990 to obtain the total electricity consumption per appliance. The sum of the disaggregated projections is compared to other independent projections based on extrapolation and econometric methods. (auth)

CN-129,952

1973

N74-10833# Transportation Systems Center, Cambridge, Mass.

ENERGY STATISTICS: A SUPPLEMENT TO THE SUMMARY OF NATIONAL TRANSPORTATION STATISTICS Final

Report Jun. - Jul. 1973

Gill V. Hicks. Sep. 1973 94 p. refs
(PB-225331/8GA. DOT-TSC-OST-73-34) Avail: NTIS

HC \$3.75 CSCI 05C

The report is a compendium of selected time series data describing the transportation, promotion, processing, and consumption of energy. The report is divided into three main sections. The first contains such items as the revenues and expenses of oil pipeline companies, number and capacities of U.S. tank ships, and the total crude oil transported in the U.S. by methods of transportation. The second section reveals the growth over time of the U.S. oil and natural gas reserves, refinery capacity, and yields. Trends in demand for fuel and power are displayed in the third section. Throughout this part, the transportation sector is emphasized. Included are the gasoline and oil costs of automobiles of different sizes, the consumption of petroleum by type of product, the energy intensiveness of the air carriers, the electrical energy consumed by the local transit industry, and other important statistics describing the supply and demand for energy. GRA

N74-11743# Old Dominion Univ., Norfolk, Va. Dept. of Mechanical Engineering.

THE ENERGY DILEMMA AND ITS IMPACT ON AIR TRANSPORTATION

Calvin R. Dyer, ed., Michael Z. Sincoff, ed., and Paul D. Critchins, ed. 1973 171 p. refs

(Grant NGT-47-003-028)

(NASA-CR-135993) Avail: NTIS HC \$10.75 CSCI 05A

The dimensions of the energy situation are discussed in relation to air travel. Energy conservation, fuel consumption, and combustion efficiency are examined, as well as the proposal for subsonic aircraft using hydrogen fuel. For individual titles, see N74-11744 through N74-11748.

WHERE HAS ALL THE FUEL GONE?

Flight International, Nov. 22, 1973, p. 840-841.

Aircraft fuel consumption.

FOOD PRODUCTION AND THE ENERGY CRISIS.

Pimentel, D. (State Univ. of New York, Ithaca); Hurd, L. E.; Bellotti, A. C.; Forster, M. J.; Oka, I. N.; Sholes, O. D.; Whiteman, R. J. Science; 182: No. 4111, 443-449 (2 Nov 1973).

Agriculture is dependent upon fossil energy, and crop production costs will soar when fuel costs increase two- to fivefold. A return of 2.8 kcal of grain per 1 kcal of fuel input may then be uneconomical. Green-revolution agriculture also uses high-energy-crop-production technology, especially with respect to fertilizers and pesticides. To reduce energy inputs, green revolution and U. S. agriculture might employ such alternatives as rotations and green manures to reduce the high energy demand of chemical fertilizers and pesticides. U. S. agriculture might also reduce energy expenditures by substituting some manpower currently displaced by mechanization. When conventional energy resources become scarce and expensive, the impact on agriculture as an industry and a way of life will be significant. (79 references) (M/CW)

DEVELOPMENT TRENDS IN ENERGY CONSUMPTION AND ENERGY GENERATION IN THE CHEMICAL INDUSTRY.

Figner, H. Combustion; 5: No. 3, 18-24 (Sep 1973).

The history of power plants built by German chemical companies to supply their energy needs in the 1920-1940 period is reviewed, and the role of the chemical industry in industrial energy consumption in West Germany as projected to 1980 is described. Data are presented on electric power consumption for the production of: chlorine, the largest consumer of electricity in the chemical industry; calcium carbide; phosphorus; synthetic gases; petroleum; silicon carbide, and ethylene. The trend in energy consumption in West German industry as a whole is compared with the chemical industry. Finally, the main factors that affect energy consumption and its structure are discussed. These include West German policies on environmental considerations, economic factors, tax laws, reliability of supplies, supply of natural resources, and nuclear power development. (LCL)

(ORNL-NSF-EP-59) ROOM AIR CONDITIONER AS AN ENERGY CONSUMER. Moyers, J. C. (Oak Ridge National Lab., Tenn. (USA)). Oct 1973. Contract W-7405-eng-26. 36p. Dep. NTIS \$4.00.

As a part of the ORNL-NSF Environmental Program's effort toward conservation of energy, large differences in the efficiency with which room air conditioners consume electricity to provide cooling are pointed out and examined. Efficiencies range from 4.9 to 12.2 Btu/watt-hr. An improvement in average efficiency from 6 to 10 Btu/watt-hr is estimated to result in a total saving of 212 billion kw-hr during the 1973-80 period and a reduction in connected load to the electrical utilities in 1980 of almost 58,000 MW. A method for predicting the change in efficiency due to a change in design is developed and used to estimate the additional cost entailed in providing higher efficiency. A simple method for evaluating the monetary worth of the power saving at higher efficiency, from the individual's standpoint, is presented. (auth)

TITLE: A Study of The Refractories Industry - Its Relationship to The U.S. Economy and Its Energy Needs

AUTHOR: Barr, R.W., Jr.; Myers, R.P.; Fisher,

W.H.; Duckworth, W.H.; McCoy, L.G.

CORPORATE AUTHOR: Battelle, Columbus Laboratories

ADDRESS: 505 King Avenue, Columbus, OH 43201

PUBLICATION DESCRIPTION: 125 p. report

PUBLICATION DATE: 1973, October 5

SPONSOR: The Refractories Institute, 1102 One

Oliver Plaza, Pittsburgh, PA 15222

ABSTRACT: This report discusses refractories, what they are, who makes them, and where they are used. Using an input-output model of the

economy, the impact of refractories on the U.S. economy is analyzed. The analysis shows

that any reduction in the output of refractories will result in a proportional

decrease in industrial production. It is concluded that it is in the national interest

to permit some increases in energy usage by the refractory industry even when energy

resources are being allocated. (RPG)

(ORNL-NSF-EP-57) ENERGY USE FOR FOOD IN THE UNITED STATES. Hirst, E. (Oak Ridge National Lab., Tenn. (USA)). Oct 1973. Contract W-7405-eng-26. 46p. NTIS \$4.50.

The energy used in food-related activities in the United States — from agriculture to final consumption — is computed for the year 1963 using energy input/output tables developed at ORNL and economic input/output data from the Department of Commerce. A total of 6,100 trillion Btu — 12% of total 1963 energy consumption — was required to grow, process, transport, wholesale, retail, refrigerate, and cook food. This includes 190 billion kWhr, 22% of total electricity use that year. Farming accounted for less than one-fifth of the energy used for food. Farming and processing together used just over half the total. The remainder was used for transportation, trade, and household functions. Between 1960 and 1970, food-related energy use grew at an estimated 3.3% a year. This growth rate was greater than that for population but less than that for total energy use. On average, 6.4 Btu of primary energy were consumed in delivering one Btu of food energy to final demand. The comparable protein ratio was 840 Btu of primary energy per gram of food protein. (auth)

(CONF-730904-4) ROLE OF ENERGY IN AGRO-INDUSTRIAL DEVELOPMENT. Hammond, E. P. (Oak Ridge National Lab., Tenn.). [ed]. 6p. Dep. NTIS \$3.00.

From fourth international symposium on fresh water from the sea; Heidelberg, F. R. Germany (9 Sep 1973).

Experience has shown that both agricultural and industrial sectors of any region must be developed together, and that both are dependent on access to cheap energy, which plays a key role. An agro-industrial complex is an efficient way to provide a balanced input of energy and technology. Such a complex, and the more general concept of an energy center, gains efficiency in capital cost, fuel cost, land use, transport, raw material consumption, and in the use of human resources. The inherently large size of a complex is a disadvantage, but there are several ways in which this problem can be minimized. (auth)

CAMPUS UTILITY COSTS. Furner, B. O. (Heath Engineering Co., Salt Lake City). Heat., Piping Air Cond.; 46: No. 12, 85-93 (Nov 1973).

Studies were made at three Utah university complexes to determine utility consumptions at individual buildings. One of the first deletions as an economy move is the metering system to each building. Meters and recorders were loaned to the universities for the studies. Installed on the main utilities, and used to accumulate the required data on heating, water services, and electric power use. The data can be used to estimate utility consumptions and costs for existing buildings not metered, buildings under construction, and future buildings for possible means of energy conservation. (MCW)

POWER GENERATION AT THE TOP 100 ELECTRIC COMPANIES. Owens, K. R. Elec. Light Power (Boston); 51: No. 13, 26-35 (Jul 1973).

Some large electric power producers made adjustments in 1972 to accommodate the fuel crisis. The wide swings are shown in coal, oil, and gas consumption in a table ranking the top 100 power generating companies, with comparisons for 1971, on heat rates and fuel consumption data. Where natural gas could be bought, the consumption — primarily for use in gas turbines — went up considerably. Where the gas could not be bought, the companies used considerable quantities of oil, the quality of which varied from #2 diesel fuel to heavy crude, causing higher maintenance rates. Peak demand and capability for the 100 companies were also tabulated. The amount of fossil, hydro, gas turbine and diesel, and nuclear power generation in each of the top companies is listed. It is concluded that the ultimate answer to the national energy problem, according to the president's message, is expanded research and development. The essence of the statistics provided on fuel consumption by the electric companies now shows a stable pattern. (MCW)

(CONF-731106-5) POLLUTION CONTROL ENERGY COSTS. Hirst, E. (Oak Ridge National Lab., Tenn. (USA)). 1973. 28p. Dep. NTIS \$3.50.

From winter meeting of American Society of Mechanical Engineers; Detroit, Michigan, USA (11 Nov 1973).

The amounts of energy needed for or saved by operation of several environmental protection strategies are examined. The areas considered include: urban passenger traffic, waste water treatment, solid waste management, air-pollution control, and waste heat dissipation. The energy required to meet the environmental needs discussed — based on the limitations and assumptions in this study — are small relative to total energy use. (auth)

CE-129,706
ENERGY FACT SHEETS BY STATES AND REGIONS -
UNITED STATES. Feb. 1973. 136p.

Department of the Interior

Power sources

Energy consumption
Earth - Resources
Tables - Energy

(BNWL-SA-4843) USE OF LINEAR PROGRAMMING
TO MODEL BUSINESS AND CONSUMER DECISION MAKING RE-
LATED TO ENERGY CONSUMPTION. Decald, D. E. (Battelle
Pacific Northwest Labs., Richland, Wash. (USA)). [ed]. 32p.
(CONF-731130-2). Dep. NTIS \$3.75.

From Operation Research Society of America; San Diego, Cali-
fornia, USA (12 Nov 1973).

Models that predict the response of business and consumers to
changes in energy cost have been made previously, but with today's
energy economy, the models do not apply. Prices are rising at
an unprecedented rate and the availability and environmental con-
straints also influence the choice of fuels as well as prices. With these
factors, the new linear programming was designed to determine
the electrical generation supply for the next 50 years taking into
account the advent of nuclear power. The model is formulated to
simulate a schedule of building power plants that will supply pro-
jected energy requirements while also satisfying constraints repre-
senting material balances, technological introduction rate con-
straints, fuel price step functions, committed plant construction,
and fuel-processing capacity. (MCW)

US CONSUMPTION OF ENERGY IN 1972: PRELIM-
INARY FIGURES. Energy Policy; 1: No. 1, 85-86(Jun 1973).
Total energy consumption in 1972 is estimated to be 72.881 x
10¹² Btu, a 4.5% increase over 1971. The distribution among the
various energy sources is tabulated for 1971 and 1972. Net im-
ports of all fuels increased 24.5% over 1971; the net trade in
fossil (mineral) fuels is also tabulated. Production of energy
sources is discussed: fossils, nuclear, hydro. (DLC)

N74-106764 RAND Corp., Santa Monica, Calif.
MEASURES FOR SLOWING GROWTH IN ELECTRICITY
CONSUMPTION

Ronald D. Doctor Apr. 1973 18 p refs Presented at Hearing
of Subcommittee on State Elec. Energy Policy of Calif. State Assembly
Comm. on Planning and Land Use, Sacramento, 23 Feb. 1973
Sponsored by NSF

(P-5017) Avail: NTIS HC \$3.00

Methods for reducing the growth rate of electricity demand
are examined. The greatest opportunities for slowing growth were
found in the residential and commercial sectors. Measures for
conserving energy are presented, such as improved insulation,
solar energy, gas substitution, increased air conditioning efficiency,
decreased electricity for lighting, and low energy buildings.

J.A.M.

ENERGY IN THE USA AFTER THE PRESIDENT'S
MESSAGES: CHANGES IN INVESTMENT AND BALANCE OF
PAYMENTS. Simon, W. E. (Dept. of the Treasury, Washington,
DC). Energy Policy; 1: No. 3, 187-194(Dec 1973).

The energy problems of the USA up to 1980 are examined from
the vantage point of the Treasury Department and the Oil Policy
Committee. How present difficulties arose and what will be the
impact of the President's new proposals on further exploration
and development for oil production, on refinery construction, and
on balance of payments are discussed. The effect of the action
may change the way of life in the developed world, and it could
be for the better if this is used as an opportunity to eliminate
waste and strive for efficiency in energy use. (MCW)

N74-12678* Auburn Univ., Ala.

ENERGY CONSUMPTION: PAST, PRESENT, FUTURE
In: TERRASTAR: Terrest. Appl. of Solar Technol. and Res.
Sep. 1973 27 p refs (For availability see N74-12674 03-34)
CSCI 20M

The energy consumption history of the United States and
the changes which could occur in consumption characteristics
in the next 50 years are presented. The various sources of energy
are analyzed to show the limitations involved in development
and utilization as a function of time available. Several scenarios
were prepared to show the consumption and supply of energy
under varying conditions.

Author

N74-14895# Oak Ridge National Lab., Tenn.
ELECTRIC ENERGY REQUIREMENTS FOR ENVIRONMENTAL PROTECTION

E. Hirst and T. Healy 1973 20 p refs Presented at Conf. on Energy, Demand, Conserv., and Inst. Probl., Cambridge, Mass., 12 Feb. 1973 Sponsored in part by AEC and NSF Prepared in cooperation with Santa Clara Univ., Calif.
(Conf-730205-4) Avail: NTIS HC \$3.00

The amount of electricity needed for (or saved by) operation of several environmental quality strategies is examined. These strategies include: electric mass transit, waste water treatment, solid waste disposal, air pollution control, waste heat dissipation, and electricity conservation. Energy requirements of existing electric mass transit systems are compared with the new BART system, buses, and autos. Electric energy costs, as a function of plant size, are examined for primary/secondary sewage plants. Electricity costs and savings are computed for solid waste disposal, recycle, and use as fuel. Electricity needs for air pollution control at stationary sources and from motor vehicles are evaluated. Electricity needs for use of cooling towers at power plants are reviewed. Finally, potential energy savings which reduce air and thermal pollution levels are examined. The electricity required to meet the needs discussed here-based on the assumptions in this study-are small relative to total kilowatt-hour consumption.

Author (NSA)

N74-20617# Arkansas Univ., Fayetteville. Dept. of Physics.
ENERGY IN THE NEAR TERM

Otto Henry Zinke 21 Jun. 1973 57 p refs Sponsored by Dept. of Commerce and Ford Found.
Avail: NTIS HC \$6.00

The dependence of the United States on petroleum as a primary energy source is discussed. Data are presented which outline energy consumption and production estimates. Techniques which would reduce energy consumption are outlined. Correlations are made between energy consumption and employment.

S.K.W.

Environment, v.15, no.8, Oct.1973.

THE ENERGY COST OF POLLUTION CONTROL

Eric Hirst

Better reclamation of waste and improved transportation systems would decrease our energy needs by 3.2 percent; air and water pollution controls and solid waste disposal will increase energy demand by 3.7 percent. The net effect of environmental improvement measures on energy demand will therefore be negligible, despite recent advertising to the contrary.

37

(PB-227172-4-WE) RESIDENTIAL DEMAND FOR ELECTRICITY IN NEW ENGLAND. Levy, P. F. (Massachusetts Inst. of Tech., Cambridge (USA)). Nov 1973. 124p. (MIT-EL-73-17). NTIS \$3.35.

The residential demand for electricity at a very detailed level of aggregation is examined. An econometric model is developed for the New England region using a cross-section of sixty-seven electric utilities and their service areas as the data base. Both supply price and demand equations are estimated, using the two-stage least squares technique, to account for the simultaneous nature of the system. Conclusions are presented and policy implications discussed. Suggestions for future work in the field are also presented. (NTIS)

TITLE: Passenger Car Fuel Economy - Trends and Influencing Factors

AVTHOR: Austin, T.C.; Bellman, K.M.
CORPORATE AUTHOR: U.S. Environmental Protection Agency

ADDRESS: Ann Arbor, MI 48105

PUBLICATION DESCRIPTION: Paper 710790 presented at National Combined Para, Construction & Industrial Machinery and Fuels and Lubricants Meetings, Milwaukee, WI, September 10-13, 1973, 36 p., 33 references

PUBLICATION DATE: 1973

ABSTRACT: This paper discusses some trends and influencing factors in passenger car fuel economy. Fuel economy and fuel consumption were calculated by a carbon balance method from HC, CO and CO₂ emissions measured by the 1972 Federal Test Procedure. The information presented was derived from nearly 8,000 tests of passenger cars ranging from 1957 production models to 1975 prototypes. Data are presented for various model year and vehicle weight categories. Trends in fuel economy are discussed on an overall sales-weighted basis and for each individual weight class. Some of the factors that influence fuel economy are quantified through the use of a regression analysis. Particular emphasis is placed on the differences in fuel economy between those vehicles that were subject to federal emission regulations and those vehicles that were not. Three ways to characterize vehicle specific fuel consumption are presented and discussed. Possible ways to improve fuel economy and vehicle specific fuel consumption are also discussed. (Auth)
LABLIT: Society of Automotive Engineers, Inc., Two Pennsylvania Plaza, New York, NY 0001

(72-22318-0) RESIDENTIAL ENERGY CONSUMPTION VERIFICATION OF THE TIME-RESPONSE METHOD FOR HEAT LOAD CALCULATION **ANNEX 2, V. (HEAT LOAD CALCULATION)**

Societas, Inc., Columbia, Md. (USA)). Jun 1973. Contract HUD-11-1654. 23p. NTIS \$2.75.

The time-response method for calculating residential heat loads was experimentally verified using several occupied single-family residences. Calculated and measured heating requirements were compared on an hourly basis and for a 24-day test period. The results of the study demonstrated the applicability of the time-response method for calculating residential heat loads for occupied residences having average quality of construction and lifestyle patterns of the occupants. (GRA)

Electricity growth: Economic incentives and environmental quality --- consumption and pricing of electricity in United States of America. Macosela Univ., Radom. CICHETZ, C. J. JUN. 1973

47 PAGES. \$2.75. AVAILABLE FROM: NTIS SC \$3.50
*ORDERED (ECONOMICS), *ELECTRIC POWER SUPPLIES, *ENVIRONMENTAL MANAGEMENT, *UNITED STATES OF AMERICA
*COST EFFECTIVENESS, *ECONOMIC DEVELOPMENT, *ENERGY CONSUMPTION, *ENERGY POLICY, *ENVIRONMENTAL CONTROL

CS3 878-21667 8

TITLE: Factors Affecting Vehicle Fuel Economy
AUTHOR: LaPointe, C.
CORPORATE AUTHOR: Ford Motor Co., Environmental & Safety Engineering Staff
ADDRESS: Automotive Emissions Office, Room 267, WFO, Dearborn, MI 48121
PUBLICATION DESCRIPTION: Paper 730791 presented at National Combined Fairs, Construction & Industrial Machinery and Fuels and Lubricants Meetings, Milwaukee, WI, Sept. 10-13, 1973, 11 p., 6 references

PUBLICATION DATE: 1973, September
ABSTRACT: The recent history of automotive fuel economy in the United States is reviewed. As of the 1973 model year, the individual typical car on Ford's city-suburban route has experienced a 22% decline in fuel economy compared with 1967. In the aggregate, however, the decline has not been as great because an increasing proportion of small cars has entered the vehicle population. The factors which have contributed to the fuel economy decline of the typical car are average weight and engine displacement increases and measures taken to reduce exhaust emissions. As of the 1973 model year, emission controls have accounted for 60% of the total 22% decline based on Ford's city-suburban route. (Auth)
AVAILABILITY: Society of Automotive Engineers, Inc., Two Pennsylvania Plaza, New York, NY 10001

TITLE: A Study of the Quarterly Demand for Gasoline and Impacts of Alternative Gasoline Rates

CORPORATE AUTHOR: Data Resources Inc.
ADDRESS: 20 Hartsell Avenue, Lexington, MA 02173
PUBLICATION DESCRIPTION: Data Resources Special Study, 37 p., 12 references

PUBLICATION DATE: 1973, December
SPONSOR: U.S. Environmental Protection Agency; Executive Office of the President, Council on Environmental Quality

ABSTRACT: This report presents calculations of how the demand for gasoline will respond to alternative levels of prices and incomes for the next two years. Included in these calculations are specific evaluations of the direct and indirect effects of increases in the gasoline tax. The calculations are based on an econometric model of the demand for gasoline developed for the Environmental Protection Agency and the Council on Environmental Quality by Data Resources Inc. The projections are made using this model in conjunction with the DRI macroeconomic model of the U.S. economy. The study makes specific projections of how gasoline price changes affect both the demand for gasoline and the more general business pattern of the economy as a whole. (Auth, from Summary)

ENVIRONMENTAL ENERGY: Examines amounts of energy needed for air and water pollution control, solid waste disposal, and other environmental protection strategies. 19 pages. (CONF-730205-4, available through AEC/contractor channels or at a later date, from NTIS, U.S. Dept. of Commerce, Springfield, Va. 22151.)

N74-73688

N-140,010 Department of Transportation DOT-OST-TST-14

RESEARCH AND DEVELOPMENT OPPORTUNITIES FOR IMPROVED TRANSPORTATION ENERGY USAGE. (Prepared by the Transportation Energy Panel). Apr. 1973.

N74-22592# California Inst. of Tech., Pasadena. Environmental Quality Lab.

TRENDS OF ENERGY USE IN CALIFORNIA AND THE SOUTH COAST AIR BASIN

Paul K. Mazurka May 1973 58 p refs
(Grant NSF GI-29726)
(EOL-Memo-8) Avail: NTIS HC \$6.00

A time history is presented of the major sources of energy described for 1969 in List's report, 'Energy Use in California'. As the data are compiled differently in these two reports, a comparison and interpretation is shown for 1969. The major difference is that his data are only for fuel used to provide energy within the state boundaries, while this report includes consumption for uses other than energy (LPG for chemical feedstock), and fuel used outside the state that was sold in the state (oil for ocean vessels). Natural gas delivered, gasoline, and LPG burned show good agreement. California's total electricity production agrees well. For the South Coast air basin, natural gas use agrees well between the two reports, while both gasoline use and electricity use are about 7% greater in the present work.

Author

TITLE: Changes in Energy Consumption, 1963 - 1980
AUTHOR: Just, J.L.

COMPOSITE AUTHOR: Massachusetts Institute of Technology, Energy Laboratory; Massachusetts Institute of Technology, Alfred P. Sloan

SCHOOL OF MANAGEMENT

ADDRESS: Cambridge, MA 02139 **8-227580**

PUBLICATION DATE: 1973, February

SPONSOR: National Science Foundation, RANN

PROGRAM: Nitro Corp.

ABSTRACT: The actual 1963 and the projected 1970 and 1980 input-output tables are used to analyze changes in energy consumption between 1963 and 1970 and 1970 and 1980. These changes are broken down into two components: those caused by technological change and those caused by final demand growth. The analysis is performed by converting the dollar flows of the input-output tables into energy flows in BTU's. Various sectors of the economy are ranked according to energy use based on total consumption, consumption per unit of output, and consumption per unit of final demand sale. These rankings are made for coal, oil, natural gas, and electricity consumption. The results indicate that the technology of energy use efficiency has not been improving as rapidly as in the past and that by 1980 technology will actually result in increased energy use caused by greater electricity and natural gas consumption. Policy implications are also discussed. (Auth)

TITLE: Statistical Year Book of the Electric Utility Industry for 1972
CORPORATE AUTHOR: Edison Electric Institute
ADDRESS: 90 Park Avenue, New York, NY 10016
PUBLICATION DESCRIPTION: Report No. 80, Publication No. 73-13, 70 p.

PUBLICATION DATE: 1973, November
ABSTRACT: Statistical data in this report represent information from United States sources of electric power generation by type of ownership. The Total Electric Utility Industry which includes all plants commonly referred to as contributing to the public supply is the principal source, and all complete information given is based on this source except in the Financial Section. In this section the dissimilarity between Investor-Owned Electric Utilities and others of the component groups makes comparison of overall financial data difficult. When extrapolation of source data to provide 100 percent coverage is necessary, figures are based on reports covering more than 99 percent of the ultimate customers of the Investor-Owned Electric Utilities and 86 percent of the cooperatively and governmentally owned electric utilities. The Total Electric Utility Industry, Major sections of the report are as follows: installed generating capacity in the United States; electric power generation by states and kinds of fuel; weekly output of electricity; energy sales; customers; revenues; operating data and ratios; construction expenditures; financial statements; and stocks, bonds and consumer price index information. Summary tables of the statistical data are presented. (MCS)
AVAILABILITY: Edison Electric Institute, 90 Park Ave., New York, NY 10016 (\$8.00)

73-20699# Study of Process Energy Requirements for

U.S. Industries
 AUTHOR: Roberts, T.J. (Chairman); Morse, R.J. (Chairman); Anthon, A.; Brooks, R.A.; Brey, P.; Finkelman, S.; Fleming, R.C.; Gibeault, S.A.; Hendrick, R.L.; Reedy, R.L.; Hills, R.S.; Krieger, R.A.; Ziegler, C.E.
 CORPORATE AUTHOR: American Gas Association Inc., Industrial Sales Promotion Committee, National Extension Task Force
 ADDRESS: 605 Third Avenue, New York, NY 10016
 PUBLICATION DESCRIPTION: Series of 10 reports, Catalog No. C-20690, 920 p.
 PUBLICATION DATE: no date
 ABSTRACT: This series of ten reports discusses process heat requirements in the following industries: non ferrous metals, cement and lime, paper and pulp, chemicals, iron and steel, chemical, rubber and plastics, food, textile, and glass. Total energy requirements, present gas usage, and the technical and economic bases for present practices are presented. Wherever possible, the market information is broken down by states. (1973)

A Report on Automobile Fuel Economy.
 Environmental Protection Agency, Washington, D.C. Office of Mobile Source Air Pollution Control. Oct 73. 42p
 PB-229 796/8WE PC\$5.25/MF\$1.45

The results of the Environmental Protection Agencies' analysis of fuel economy data from more than 4,000 cars tested on the Federal Driving Cycle are presented. Vehicle weight is the single most important vehicle design parameter affecting-fuel economy.

74-20699# Stanford Research Inst., Menlo Park, Calif.
PATTERNS OF ENERGY CONSUMPTION IN THE UNITED STATES
 Jan. 1972 236 p refs Sponsored by Office of Sci. and Technol.
 Avail: SOD HC \$2.25

The objectives of the study are to determine: (1) what significant purposes have fuels been used for in the United States; (2) what portion of the nation's energy requirements for the various end uses have been met by each fuel; (3) what has been the rate of growth of consumption in the major end uses of each fuel; (4) what technical efficiency can be expected when each fuel is used for those end uses for which it is suitable; The emphasis of the study was on the residential, commercial, and industrial sectors, the use of electric power has also been incorporated, along with the transportation sector, in order to arrive at a total energy balance. This report is strictly a factual document; its purpose is to provide the most detailed information practicable on how the nation uses its energy. Author

73-23982# RAND Corp., Santa Monica, Calif.

GROWTH RATES WITHIN THE TRANSPORTATION SECTOR
 W. E. Moor Jan. 1973 10 p Presented at Sem. on Energy as a Scarce Resource, Pasadena, Calif., 9 Dec. 1972; sponsored by Environ. Qual. Lab., the Sierra Club, and League of Women Voters
 Avail: NTIS HC \$3.00 (P-4935)
 Report is made of an investigation into the nature of transportation in terms of energy depletion and fuel consumption. Graphic profiles are presented which trace the growth rates of specific modes of passenger and freight transportation from 1955 to 1968. A summary of likely transportation energy demands for the future is also included. J.M.M.

73-23982# RAND Corp., Santa Monica, Calif.
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73-20699# Mize Corp., McLean, Va. Transportation Systems Engineering Dept. *also CN-129,799*
US TRANSPORTATION: SOME ENERGY AND ENVIRONMENTAL CONSIDERATIONS

W. E. Fraze Sep. 1972 50 p refs
 (PB-213034; MITRE-72-164) Avail: NTIS HC \$3.75 CSCL 138

The role of transportation in air pollution and consumption of energy, especially petroleum, is reviewed, with emphasis on the U.S. situation. Both technological and control measures for each problem area are discussed. Technological measures focus on the automobile, high speed ground transportation modes, and non-petroleum fuels, while control measures, which encourage the use of the more efficient transportation modes, are seen to offer significant benefits. The near future is discussed with respect to the impact of the U.S. Amended Clean Air Act of 1970. Transportation evolution over the next few decades is projected. Author (GRA)

1972

Energy Consumption and Electric Supply Influences.

David C. White.

Massachusetts Inst. of Tech., Cambridge. 3 Nov 72. 13p

NSF-RA/N-73-049

PB-228 261/4WE PCS4.00/MFS1.45

Today's U.S. energy problem is not just based on resources or environmental degradation but is much more fundamental. There appears to be a basic mismatch between the relative short time response of the market place and the much longer time response for changes in supply capability. Much of today's energy crisis is due to this mismatch and no method of dealing with it adequately has yet been developed. In the period being faced today and for the next several decades, with the structure of the energy industry adjusting to the new resource and environmental constraints, there are approaches which will help the supply-demand balance, and these require much more attention to the way energy is used to perform the necessary functions of our industrialized society.

N73-20819# Battelle Columbus Labs., Ohio.

A BRIEF OVERVIEW OF THE ENERGY REQUIREMENTS OF THE DEPARTMENT OF DEFENSE Final Report

R. W. Sullivan, F. A. Creswick, D. E. Erb, M. S. Fortas, and D. D. Moore Aug. 1972 137 p refs Sponsored in part by ARPA, Arlington, Va.

(Contract DAAH01-72-C-0982)

(AD-754824) Avail: NTIS SC5L 21/4

The report documents the results of a brief program to review the magnitude and nature of the energy requirements of the Department of Defense (DoD) and to identify research and development activities or other actions which should be undertaken by the DoD in order to minimize or ameliorate its energy-related problems. Some of the topics include the following: Energy resources (coal, oil, natural gas, uranium, fusion energy, hydrogen energy); Energy consumption and projections for future requirements; Energy problems; and Specific recommendations (Develop domestic sources of substitute liquid petroleum fuel from oil shale and coal, improve the efficiency of piston and turbine engines, develop strategies for military use of hydrogen as an alternate energy source).

Energy use in the United States, 1880-1966.

R.T. Nash and J.W. Williamson.

Fuel, v.51, no.4, Oct.1972, p.258-266.

CN-129,789

1972

PATTERNS OF ENERGY CONSUMPTION IN THE UNITED STATES. (Prepared by S.R.I.). Jan.1972. 156p. & app.

Executive Office of the President
Office of Science and Technology
Stanford Research Inst.

ABSTRACT: The Energy Policy Staff of the President's Office of Science and Technology has retained Stanford Research Institute to delineate the trends in energy consumption that have prevailed since 1960, in the important specific end uses in the residential, commercial, and industrial sectors of the U.S. economy. The objectives of the study are to determine: (1) What significant purposes (end uses) have fuels been used for in the United States? (2) What portion of the nation's energy requirements for the various end uses have been met by each fuel? (3) What has been the rate of growth of consumption in the major end uses of each fuel? (4) What technical efficiency can be expected when each fuel is used for those end uses for which it is suitable? While the emphasis of the study has been on the residential, commercial, and industrial sectors, the use of electric power has also been incorporated, along with the transportation sector, in order to arrive at a total energy balance. (auth)

AVAILABILITY: GPO, Stock No. 4106-0994 (\$2.25)

N74-20899# Stanford Research Inst., Menlo Park, Calif.
PATTERNS OF ENERGY CONSUMPTION IN THE UNITED STATES

Jan. 1972 236 p refs Sponsored by Office of Sci. and Technol.

Avail: SOD HC \$2.25

The objectives of the study are to determine: (1) what significant purposes have fuels been used for in the United States; (2) what portion of the nation's energy requirements for the various end uses have been met by each fuel; (3) what has been the rate of growth of consumption in the major end uses of each fuel; (4) what technical efficiency can be expected when each fuel is used for those end uses for which it is suitable; The emphasis of the study was on the residential, commercial, and industrial sectors, the use of electric power has also been incorporated, along with the transportation sector, in order to arrive at a total energy balance. This report is strictly a factual document; its purpose is to provide the most detailed information practicable on how the nation uses its energy. Author

1972

W72-74313#
Oak Ridge National Lab.
Contract W-7405-eng-26

ENERGY CONSUMPTION FOR TRANSPORTATION IN THE U.S.
Erie Hurst. March 1972.

ABSTRACT: Historical, present, and possible future patterns of energy consumption in the transportation sector are examined for inter-city freight and passenger traffic and for urban passenger traffic. The energy-efficiencies among the various transport modes are quite variable. Airplanes are relatively inefficient; cars and trucks are slightly more efficient; and railroads, waterways, pipelines, and buses are quite efficient. The energy implications of changes in the modal mix for freight and passenger transport are explored using two hypothetical futures. The energy required, directly and indirectly, for automobiles in American society is also computed. This includes the energy needed to produce gasoline; to manufacture and sell cars; to repair, maintain, and insure cars; to provide replacement equipment; and to build and power cars. When total automotive energy consumption is considered the automobile accounts for about 25 percent of total U.S. energy consumption. This is equivalent to 7.1 miles per gallon for the average American car. (Nath)

CE-129,802
RESIDENTIAL ENERGY CONSUMPTION - PHASE I REPORT.
March 1972.

Hittman Associates, Inc.
Department of Housing and Urban Development
Contract (HUD)-H-1654

Energy consumption
Power sources

L-8-9-73

6

CE-129,803
RESIDENTIAL ENERGY CONSUMPTION - MULTI-FAMILY
BUILDING ACQUISITION. Oct. 1972. 76p.

Hittman Associates, Inc.
Department of Housing and Urban Development
Contract (HUD)-H-1654

Energy consumption
Power sources

1972

L-8-9-73

TITLE: Energy Use in Wisconsin - A Survey of Energy Flow in the State of Wisconsin
AUTHOR: Poell, W.K.; Rushton, J.W.
COMPANY AUTHOR: University of Wisconsin-Madison, Institute for Environmental Studies
ADDRESS: Madison, WI 53706

ABSTRACT: Madison, WI 53706
PUBLICATION DESCRIPTION: Working Paper A, 86 p.
PUBLICATION DATE: 1972, October
SPONSOR: National Science Foundation, NAW Program

ABSTRACT: We have undertaken a comprehensive study of energy usage in Wisconsin, its relationship to the state's present societal and physical characteristics, and its implications for the immediate and long-term future of the state.---The basic framework of our study is the creation of a state energy model. A model can be thought of simply as an ordered set of assumptions about a complex system. In our case, it will consist of a computerized collection of data and information about energy usage in Wisconsin, written in a simple mathematical form so as to simulate our energy system and its relationship to various social, economic and physical characteristics of the state. The model is intended to reveal significant trends, causes, and relationships, and to provide a better basis for understanding their implications for the future.---This first report represents only a preliminary collection of data, intended to provide a better feeling for state energy usage, and to reveal areas of growth and importance. The report covers all types of energy, not just electricity, since it is becoming increasingly clear that we cannot develop energy strategies on a compartmentalized basis. The bulk of the information contained in this first report deals with the physical flow of energy, i.e., types, quantities, and the purposes for which it is used. No data on pollution or other environmental effects are included here, nor is any emphasis given to social and economic data, although these are being compiled for later use in the model. (Nath, from Introduction)
AVAILABILITY: Wesley K. Poell, Nuclear Engineering/Environmental Studies, 1500 Johnson Drive, Madison, WI 53706

1972

TK2896.I55 1972

UTILIZATION ANALYSIS OF ENERGY SYSTEMS.

Part III. Urban Energy System Manufacturing Industry Data Base and Energy Maps. Brown, H. L.; Hamel, B. B.; Hinkle, R. K.; Schleyer, W. T. (Drexel Univ., Philadelphia). pp 1236-1248 of 7th Intersociety Energy Conversion Engineering Conference. Washington; American Chemical Society (1972).

From 7th intersociety energy conversion engineering conference; San Diego, California, USA (25 Sep 1972). See CONF-720925-.

The broad data requirements for analysis of an urban energy system are defined using the City of Philadelphia as an urban laboratory. The energy system is described and includes the type (electricity, gas, oil, coal, steam), amount, density, and grade or quality of energy required by the various economic sectors (manufacturing, residential, commercial, utilities, and transportation). The urban data base is established for the manufacturing industry sector in Philadelphia for the year 1969. Total energy and energy density maps for the manufacturing sector for electricity, gas, oil, and coal are presented with a breakdown of energy consumption by major industries. (MCW)

TK2896.I55 1972

UTILIZATION ANALYSIS OF ENERGY SYSTEMS.

Part II. Application of Utilization Criteria to House Energy System. Hamel, B. B.; Brown, H. L.; Crapo, R. E.; Nwude, J. K. (Drexel Univ., Philadelphia). pp 1209-1222 of 7th Intersociety Energy Conversion Engineering Conference. Washington; American Chemical Society (1972).

From 7th intersociety energy conversion engineering conference; San Diego, California, USA (25 Sep 1972). See CONF-720925-.

Energy utilization analysis and criteria are applied to the energy system of an all-electric and gas-electric house to demonstrate the feasibility of this analytical approach on a real system and to gain insight into the character of energy utilization in a house. Data show that the grade level of energy required is, on the average, low, generally being dominated by the low-grade requirements of the heating and hot-water systems. Profiles are developed to demonstrate that these energy requirements are met by having converters taking high-quality energy and producing low-grade hot water and hot air—thus, establishing a mismatch between supply and demand. Basically, two points are established about house energy-system utilization: Firstly, the requirement for low-grade thermal energy is met by taking high-quality energy from outside the system and passing it through low-performance converters. Secondly, the cascading of discharge energy improves system performance by increasing one effectiveness parameter from a value of 0.158 (without cascading) to 0.172 and improving a second from 5.64 to 5.5 relative to an ideal value of 0.393. (MCW)

1972

1972

TK2896.I55 1972

UTILIZATION ANALYSIS OF ENERGY SYSTEMS.

Part I. Fundamentals of Energy Utilization. Hamel, B. B.; Brown, H. L. (Drexel Univ., Philadelphia). pp 1196-1208 of 7th Intersociety Energy Conversion Engineering Conference. Washington; American Chemical Society (1972).

From 7th intersociety energy conversion engineering conference; San Diego, California, USA (25 Sep 1972). See CONF-720925-.

Energy utilization is defined here as: (i) system utilization, that is a measure of system performance in supplying the demand factor of the energy system; (ii) energy productivity, that is a measure of the effectiveness of the demand sector of the system i.e., product or service output per unit energy input; and (iii) system constraints, that represent the conditions imposed by the larger energy system. System utilization is developed in detail. An analytical formulation of a general energy using system is developed based upon the fundamental concept of thermodynamic availability. A general energy system is defined in terms of system elements—discrete energy users and converters. Utilization criteria and effectiveness parameters are defined in terms of

ideal performance of the system in which the reversible transfer of energy is considered ideal. From these criteria and performance parameters it is possible to determine the degree of mismatch between the quality of energy supplied and needed; the impact of cascading energy within the system; the effects of system components, with their associated coefficients and interconnection matrices, on the performance of the general energy using system; and the degree of departure of system performance from the ideal. (MCW)

1972

TK2896.I55 1972

MINIMIZATION OF RESIDENTIAL ENERGY CON-

SUMPTION. Harvey, D. G. (Hittman Associates Inc., Baltimore); Kadrick, J. A.; Laignon, G. pp 1247-1256 of 7th Intersociety Energy Conversion Engineering Conference. Washington; American Chemical Society (1972).

From 7th intersociety energy conversion engineering conference; San Diego, California, USA (25 Sep 1972). See CONF-720925-.

The current fuel crisis and rapidly increasing fuel consumption throughout the country has highlighted the need to economize on their use. With this thought in mind, Hittman Associates, Inc. under HUD sponsorship has been studying various means by which energy consumption within single-family, townhouse, and multi-family residences can be reduced without changing the basic life style of the residence. Preliminary results are presented and several potential energy saving concepts are discussed. (auth)

N74-16684 First National City Bank, New York
CAPITAL REQUIREMENTS OF THE ENERGY INDUSTRIES
 Edward Symonds in Denver Univ. Balancing Supply and Demand
 for Energy in the US 1972 p 29-37 (For availability see
 N74-16651 07-34)

The economic factors which influence the investments which should be made in developing natural resources for energy purposes are discussed. Capital outlays for the energy industries of the U.S. involving electricity, oil, gas and other are tabulated for 1970 and estimated for 1980. A similar tabulation is presented for nations of the non-Communist world. Energy demands for the U.S. and non-Communist countries from 1960 to 1980 are analyzed. Factors, other than economic which influence the amounts and types of energy available are examined. Author

TITLE: Current Situation and Future Outlook,
 Commercial and Industrial Energy Markets

AUTHOR: Linawe, D.B.

CORPORATE AUTHOR: Decision Sciences Corp.

ADDRESS: Benjamina Fox Pavilion, Portcroft Square,
 Jenkintown, PA 19046

PUBLICATION DESCRIPTION: DSC research paper No.
 165, presented to Midwest Industrial Gas
 Council, 15 p.

PUBLICATION DATE: 1972, October 6

ABSTRACT: Commercial and industrial energy markets are studied with particular emphasis on the role of gas in these markets in the present and in the future. Energy consumption is analyzed on a regional basis and correlated with personal income, and the relationships derived from this are used to predict future energy consumption. The impact of air pollution regulations and energy conservation measures are briefly considered. Analytical techniques for energy policy evaluation are also briefly mentioned. (M7)

N74-18586 Hudson Inst., Inc., Croton-on-Hudson, N.Y.
ECONOMIC BASIS FOR ENERGY AND RESOURCE USE
 Herman Kahn in Mitre Corp. Symp. on Energy Resources and
 the Environment, Vol. 1 12 Apr. 1972 p 48-104 (For availability
 see N74-18582 09-34)

An economic basis for energy and resource use to solve international societal problems in the future is presented. G.G.

(NP-19778) **TECHNO-ECONOMIC SURVEY OF
 TRENDS IN THE U. S. ELECTRIC-POWER INDUSTRY AT A
 TIME OF TRANSITION.** Part I. Summary and Conclusions.
 Interdevelopment, Inc., Arlington, Va. (USA). Sep 1972. 33p.
 Interdevelopment, Inc., Arlington, Va. (USA).

The results and conclusions of a 1971-1972 techno-economic survey of trends in the U. S. electric power industry are presented. These conclusions relate to power generating capacity, the effects of environmental considerations on the construction and operation of new generating plants, fuel economics involving coal, oil, natural gas, and nuclear fuels, required research and development programs, the development of larger capacity generating and transmission systems, the need for a national energy policy, and the effect of the increasing time lag between the ordering and operation of new generating facilities. It is concluded that due to the complicated forces acting, it is not possible to predict now whether supply can meet projected demand over the next decade or so. (LCL)

(NP-19773) **TECHNO-ECONOMIC SURVEY OF TRENDS
 IN THE U. S. ELECTRIC-POWER INDUSTRY AT A TIME OF
 TRANSITION.** Part II. Report on Investigations. (Interdevelopment, Inc., Arlington, Va. (USA)). Sep 1972. 315p. Interdevelopment, Inc., Arlington, Va. (USA).

An overall view is provided of the probable directions in the demand, production, transmission, and distribution of electric power in the U. S. Detailed information is included on: U. S. requirements and generating capacity; the structure of the U. S. electric power industry; factors acting to produce changes, such as economics, environmental considerations, fuel supply, and technological trends; fuels; research and development work on power systems; power generation systems and equipment; power plants and supply networks; transmission and distribution; and economics. (LCL)

WORLD ENERGY NEEDS IN RELATION TO ECONOMIC GROWTH AND QUALITY OF LIFE. Felix, F. Energy Int. 9: No. 7, 22-26(Jul 1972).

The latest trends of growth of use of energy and of gross national product were correlated for selected countries of the world and are presented. An elasticity coefficient is determined by a measure of the ratio of the rate at which GNP grows to the rate at which the use of energy increases. With the presentation of the data from the book "World Markets of Tomorrow" by the author, an attempt was made to dispel some of the misconceptions that have been responsible for the recent concern about the perilous from exponential growth of consumption of energy in its partnership with economic growth. Other facets of energy that were discussed include growth, productivity, convenience, social betterment, higher quality of the environment, and for survival with recycling, desalting, and synthetic industries to replace natural resources. (MCW)

CG-129,868

1972

THE IMPACT OF ELECTRICITY PRICE INCREASES ON INCOME GROUPS: WESTERN UNITED STATES AND CALIFORNIA.

M.B. Berman, M.J. Kanner and D.P. Tikhonov.

(Prepared for the Calif. State Assembly)
(Submitted in March, Sept. - R-1050-NSF/CSA)

CALIFORNIA'S ELECTRICITY QUANTITY: III: SLOWING

THE GROWTH RATE. R.D. Doctor, K.P. Anderson,
M.B. Berman, et al., dtd Sept. 1972 - CG-129,867).

Nov. 1972. 47p.

Rand Corp.

Rand Corp.

NSF GI-44

Energy

Power plants

Electricity

Earth - Resources

1-8-29-73

R-1050-NSF/CSA

R-1116-NSF/CSA

1972

ECONOMIC REPORT: INTERFUEL SUBSTITUTABILITY IN THE ELECTRIC UTILITY SECTOR OF THE U.S. ECONOMIC. Staff Report to the Federal Trade Commission. Dachesau, T. D. Washington, DC: Government Printing Office (1972). 87p. GPO \$0.45.

The extent of interfuel substitution among the primary sources of energy in the electric utility sector of the economy is analyzed, and market boundaries are determined. Primary attention is given to assessing interfuel substitution within the electric utility sector. Once it is determined whether the various fuels trade in the same market or in different markets, it is possible to decide if oil company entry via acquisition into other fuels is properly viewed as an horizontal or conglomerate movement. Conceptually, competition is properly defined as encompassing both actual and potential competition. According to economic theory the determining factor in deciding whether products trade in the same or different economic markets is the degree of substitutability between products. Substitutability may be viewed either from the buyer's viewpoint, the demand side, or from the producer's perspective, the supply side. The cross-elasticity concept is generally considered as the proper means of measuring product substitutability. An important limitation is that economic theory does not indicate a priori the critical value of the cross elasticity coefficient which, if exceeded, allows the conclusion that products trade in the same economic market. Another limiting factor is that the cross-elasticity concept measures consumer or supplier response to changes in the prices of related goods and assumes that nonprice factors are stable. Substitutability, however, especially in terms of demand, is affected by nonprice factors. In addition to conceptual limitations, certain institutional features of the energy sector also reduce the usefulness of using cross elasticity coefficients to define market boundaries. Historical fuel use and costs indicate the extent of actual substitution between the fuels. The findings in all regions of the United States are discussed. (MCW)

TITLE: Dynamic Energy System Modeling - Interfuel Competition

AUTHOR: Baughman, M.L.

CORPORATE AUTHOR: Massachusetts Institute of Technology, Energy Analysis and Planning Group

PUBLICATION DESCRIPTION: Report No. 72-1, 273 p.

PUBLICATION DATE: 1972, September

ABSTRACT: This work is an effort to combine the many economic studies of supply and/or demand for the different forms of energy into a medium to long range dynamic model of interfuel competition for the U.S. This means that a model containing the dynamic interactions between supply, demand, and price for competing forms of energy is to be constructed. Given the availability of the fuel resources and the levels of demand for each of the consuming sectors as a function of time, the model will simulate the process by which supply production capacity is constructed and resources are depleted, the processes whereby different fuels are chosen to satisfy the demand, and resolve these processes into prices and market shares for each of the forms of supply. (auth)

N72-32742? National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif. ECONOMIC STUDY OF FUTURE AIRCRAFT FUELS (1970-2000)

Arthur D. Alexander, III Sep. 1972 30 p refs (NASA-TM-X-62180) Avail: NTIS HC \$3.50 CSCL 21D

Future aircraft fuels are evaluated in terms of fuel resource availability and pricing, processing methods, and economic projections over the period 1970-2000. Liquefied hydrogen, methane and propane are examined as potential turbine engine aircraft fuels relative to current JP fuel.

Author

1972

1972

137

N74-19605# Select Committee on Small Business (U. S. House).
CONCENTRATION BY COMPETING RAW FUEL INDUSTRIES IN THE ENERGY MARKET AND ITS IMPACT ON SMALL BUSINESS. VOLUME 2: TENNESSEE VALLEY AREA

Washington GPO 1972 20 p Presented by Select Comm. on Small Business to the Comm. of the Whole House on the State of the Union, 92d Congr., 2d Sess., 8 Aug. 1972 (H-Rept-92-1313) Avail: U.S. Capitol House Document Room
Hearings investigated the monopolistic impact of the growing economic concentration in the energy field and the reasons underlying the recent increases in electric rates in the Tennessee Valley Area. Electric rates have increased 25% and coal prices have risen 100% between 1971-72. Findings and recommendations concerning the causes and solutions to the escalating energy costs are included. K.M.M.

Z4N71001 71/CO/00 1148 PAGES UNCLASSIFIED DOCUMENT
CONCENTRATION BY COMPETING RAW FUEL INDUSTRIES IN THE ENERGY MARKET AND ITS IMPACT ON SMALL BUSINESS
SELECT COMMITTEE ON SMALL BUSINESS (U. S. HOUSE). AVAIL SUBCOMM.
ON SPECIAL SMALL BUSINESS PROBLEMS
WASHINGTON GPO HEARINGS BEFORE SELECT COMM. ON SMALL BUSINESS
92D CONGR., 1ST SESS., 12-15, 20 AND 22 JUL. 1971
/ENERGY POLICY/FUELS/GOVERNMENT/INDUSTRY RELATIONS/COMMERCE/ CONGRESS/ EARTH RESOURCES

N74-16881# National Economic Research Associates, Inc., New York
6240 CN-128 158
ENERGY CONSUMPTION AND GROSS NATIONAL PRODUCT IN THE UNITED STATES: AN EXAMINATION OF A RECENT CHANGE IN THE RELATIONSHIP

1971 29 p refs
Copyright. Avail: NTIS HC \$3.50
The ratio of aggregate energy consumption to Gross National Product (the energy/GNP ratio) underwent a long-term secular decline during the period 1947-1966, following a trend that began in the 1920s. Since 1966, however, the trend has reversed and the ratio has shown an uninterrupted increase. If the trend prior to 1966 had persisted, energy consumption in 1970 would have been lower by an amount greater than the total electric utility consumption of coal in that year. An analysis of the possible reasons for this trend reversal indicates that it cannot be ascribed to any single cause but that a major part of it is apparently the result of: (1) the increasing relative importance of nonenergy uses of the fuels, (2) a tapering off in the year-to-year improvement in thermal efficiency at central power stations, and (3) the increasing relative importance of air conditioning and electric heating. The net result of these factors is a tendency toward a sustained high growth rate in aggregate energy consumption and a consequent increase in the energy/GNP ratio except in years of high GNP growth rate. Author

1972
TITLE: The Consumption of Electricity in the United States
AUTHOR: Culbertson, O.L.
CORPORATE AUTHOR: Oak Ridge National Laboratory, ORNL-NSF Environmental Program
PUBLICATION DESCRIPTION: ORNL-NSF-5, 32 p.
PUBLICATION DATE: 1971, June
SPONSOR: National Science Foundation
ABSTRACT: This report provides a condensed survey of American usage of electricity. The usage is first described on an overall basis and then in terms of residential, commercial, industrial, and other customers. To the extent that such information was found, each market is described in terms of its total and average kilowatt-hour annual consumption, the number of customers, and average price paid for electricity. Considerable information exists on residential usage for heating, air conditioning, appliances, and miscellaneous applications. Information which characterizes commercial usage is quite sparse. Industrial usage is described primarily in terms of individual industries and of unit electricity consumption by individual products. Some attention is given to electricity generation, including a breakdown by prime movers. Finally, a brief look is taken at forecasts of electricity consumption in the United States. (auth)

1971
N72-23979# RAND Corp., Santa Monica, Calif.
THE EFFECT OF FUEL PRICE INCREASES ON ENERGY INTENSIVENESS OF FREIGHT TRANSPORT
W. E. Moos Dec. 1971 55 p refs
(Rand NSF GS-313669)
(R-804-NSF) Avail: NTIS HC \$4.75

The use of energy for transporting U.S. intercity freight and the effect of higher fuel prices are analyzed. Methods of estimating unit energy consumption are developed and applied to determine average values and trends. Water transport is found to consume an average 500 BTU per ton/mile, rail 780, pipeline 1850, truck 2400, and air cargo 63,000, or 45 times the average for all transport modes in 1968. Only a small shift to air freight, from the present less than 0.2% to 2% of all intercity ton/miles, would double the average unit energy consumption for all freight modes. If present trends continue, this increase will occur by the year 1986. Because of its high fuel consumption, however, air freight growth would tend to be inhibited by higher fuel prices. While surface transport would be little affected, higher fuel prices may result from shortages, the cost of environmental constraints, new taxes, or other reasons. Author

74071753 68/00/00 123 PAGES UNCLASSIFIED DOCUMENT
COMPETITION AND GROWTH IN AMERICAN ENERGY MARKETS, 1947 - 1985
TEXAS EASTERN TRANSMISSION CORP., HOUSTON. AVAIL-NTIS
/*ELECTRIC POWER SUPPLIES/*ENERGY REQUIREMENTS/ COAL/ COMMERCIAL
ENERGY/ CRUDE OIL/ ENERGY CONVERSION/ INDUSTRIAL ENERGY/ NATURAL
GAS

G. CONSERVATION

ENERGY CONSERVATION: Interim findings and proposals by industry advisers to the Interior Department. Covers short-term prospects for conservation in industry, residential, commercial, transportation and electric utility segments, and outlines areas for future, more detailed investigation. 85 pages. (Energy Conservation in the U.S.: Short-Term Potential 1974-1978, available at \$3.00 from Director of Information, National Petroleum Council, 1625 K St., N.W., Washington, D.C. 20006.)

Science, v.184, no.4134, Apr.19,1974.

Conservation in Industry: C. A. Berg	264
Energy Conservation at an Industrial Research Center: A. E. Brown and E. B. Berkowitz	271

ENERGY CONSERVATION IN EXISTING PLANTS.

J.C. Robertson.
Chemical Engineering, v.81, no.2, Jan.21,1974,
p.104-111.

Describes many of the ingenious ways of conserving energy.

DESIGNING FOR THE ENERGY CRISIS: EFFICIENCY BY DECREE.

R.A. Jacobson.
Machine Design, v.46, no.11, May 2,1974, p.98-104.

Uncle Sam says that efficiency data soon will be part of the labeling on major appliances intended for use in the home. Cars will have to meet gas-mileage standards. The message is clear: Improve the efficiency of your energy-consuming products or you won't be able to sell them.

ENTHALPY CONTROL SYSTEMS: INCREASED ENERGY CONSERVATION. Shavitt, G. (Honeywell Commercial Div., Arlington Heights, IL. Heat., Piping Air Cond., 46: No. 1, 117-122(Jan 1974).

Data collected from Los Angeles, San Diego, and San Francisco reveal that controlling outside and return air dampers from an enthalpy standpoint, a tangible energy savings are accomplished over an economizer control system. Developments in electronics have brought forth commercial grade controls with excellent temperature and humidity accuracies and enabled electronically combining the two to get the measurement of the composite energy of air on a continuous basis. The result is enthalpy override control that is economically feasible for small, single-fan systems. (MCW)

CONSERVATION (ENERGY)-A MARKETING DILEMMA, A RESEARCH CHALLENGE.

L.W. Fish.
Pub. Util. Fortn., v.93, no.10, May 1974,
p.17-20.

UNIQUE ALL-AIR SYSTEM CONSERVES ENERGY IN UNITED CALIFORNIA BANK. Levine, A. Z. (Syska and Hennessy, Inc., Los Angeles). Heat., Piping Air Cond., 46: No. 1, 52-55 (Jan 1974).

The design of the all-air system in the United California Bank building in Los Angeles is described. The variable temperature supply combined with variable air volume and a unique double duct approach reduces the shaft and fan room space in the tallest building west of Chicago. Three cooling-only and one heating-cooling combination air handling units feed cold and warm air loops on individual floors. Switching dampers control flow of air from combination air handler to cold and warm loops as required. The fifth air handler, used for heating only, handles load for shaded exposures during cooler or sunny weather when capacity of the three cooling-only units is exceeded. (MCW)

COMPUTER PROGRAMS POINT THE WAY TO ENERGY CONSERVATION. Bridges, D. (Trane Co., La Crosse, WI). Heat., Piping Air Cond., 46: No. 1, 93-97 (Jan 1974).

The potential for energy savings and corresponding cost reductions or profit improvements is studied for a twenty-story office building near Los Angeles, Calif.; an industrial plant at Lexington, Ky.; and an administration building at La Crosse, Wis. The study evolved from a basic design, and energy saving ideas are then evaluated against this base to determine their economic feasibility. For an existing building, the as-installed systems represent the base. The case histories reported are based on studies using TRACE (Trane Air Conditioning Economics), which calculates loads, simulates system and equipment operation, and prepares a detailed economic analysis. (MCW)

HOW MANY MORE MILES PER GALLON?

A. Curtis.
New Scientist, Mar. 7, 1974, p. 601-603.

An examination of major improvements that could be made to the conventional piston engine to improve fuel consumption.

DESIGNING THE ENERGY MISER.

R.E. Herzog and R.T. Dann.
Machine Design, Feb. 21, 1974, p. 97-106.

The pressure is on wringing every last drop of efficiency out of your product while, of course, holding down costs. High efficiency won't come easily, but there are proven ideas and techniques that may help, and some speculative new concepts that appear promising.

CONSERVING UTILITIES: ENERGY IN NEW CONSTRUCTION.

C.E. Schumacher.
Chemical Eng., Feb. 18, 1974, p. 133-138.

The rising cost of energy makes its conservation important whenever possible. Utilities are a prime target; here are some things you can do.

ENERGY CONSERVATION IN NEW-PLANT DESIGN.

J.B. Fleming, et al.
Chemical Engineering, v. 81, no. 2, Jan. 21, 1974, p. 112-122.

1974

EXXON USA, First Quarter, 1974, v.8, no.1.

10 USING ENERGY EFFICIENTLY, by Downs Matthews

We're learning to do more work with less energy so as to

conserve fuels in short supply.

Photos by Tracy Bortland, Carl Roodman, Bill Espridge.

and Leo Touchet.

CONTROL OF ENERGY DEMAND REDUCES OPERATING COSTS.

B.H. Murphy and R.E. Putman.

Westinghouse Engineer, v.34, no.1, Jan.1974, p
p.10-15.

A computer controlled system.

THE AIRSHIP CAN MEET THE ENERGY CHALLENGE.

J.G. Vaeth.

Astronautics & Aeronautics, v.12, no.2, Feb.1974,
p.25-27.

THE AIRSHIP can be designed to move cargo pieces weighing a million pounds and more into difficult-to-reach places at energy expenditures matching our resources.

1974

A TECHNICAL BASIS FOR ENERGY CONSERVATION.

C.A. Berg, Fed. Power Commission.

Mech. Engineering, v.96, no.5, May 1974, p.30-42.

With cheap fuel a thing of the past, fuel efficiency looms as a sharp necessity for two crucial reasons: to maintain a competitive industry and to supply the goods and services society deems desirable. Inefficiencies at the point of consumption are a greatly neglected area. The nation's hotwater heaters, for example, waste more fuel than the entire aluminum industry consumes.

A74-19726

The fuel crisis and the controller. J. E. McNamara (Air Transport Association of America, Washington, D.C.). *Journal of Air Traffic Control*, vol. 16, Jan. Feb. 1974, p. 5-9.

The effectiveness of the use of optimum flight profiles as a means of reducing the fuel crisis is studied on the basis of selected performance data for the B-727-200 series aircraft. It is shown that the success of airline fuel conservation programs will depend on the controller and the facility planner. A discussion of a method of measuring fuel savings shows that a descent profile must be applied to existing procedures to determine where these savings can be realized.

V.P.

BUILDINGS OF THE FUTURE WILL SAVE FUEL.

U.S. News & World Rept., Feb.18,1974, p.47,48.

Architects are searching for ways to economize on energy in the new homes and offices they design. Some progress is evident already.

1974

DESIGNING FOR THE ENERGY CRISIS-3: PROCESSES THAT CONSERVE POWER. J.C. Bittence.

Machine Design, v.46, no.8, Apr.4,1974, p.94-102.

Designers may have to answer for products that require an inordinate amount of energy to manufacture—the future guarantees a lean and more costly energy supply. Manufacturers say that energy may become so valuable that no one will be able to ignore its contribution to the cost of making a product. The problem has only recently been recognized and there is no immediate solution.

1974

The Futurist, v.8, no.1, Feb.1974

The Long-Term Value of the Energy Crisis

By Russell E. Train

14

The energy crisis could turn out to be one of the best things that ever happened, suggests a leading conservationist who is now the Administrator of the U.S. Environmental Protection Agency. He believes the crisis may lead more people to realize that the earth is not a throwaway commodity and that they must learn a new style of life that emphasizes recycling and the prudent use of resources.

AIRCRAFT FUEL-SAVINGS MEASURES DEBATED.

M.L. Yaffee.

Aviation Wk & Space Tech., Apr.1,1974, p.49.

Technology Review, 76, no.4

Feb.
1974

HOW SHALL WE CONSERVE ENERGY?

A Technical Basis for Energy Conservation

Charles A. Berg

Energy is a commodity with both quality and quantity. We often emphasize the latter—and at our peril fail to understand the former

14

Options for Energy Conservation
Bruce Hannon

24

Before we can save energy effectively, we must understand how—and how intensively—we use it. Here is a model which reveals the inter-related inputs of labor and energy by sectors of the American economy—and the extent of their interdependence

Energy Thrift in Packaging and Marketing

R. Stephen Berry and Hiro Makino

32

Toward More Transportation with Less Energy
Richard A. Rice

44

Some suggestions—whose price in comfort and security is negligibly low—for fulfilling the social (and technological) ethic that free energy shall not be wasted

Our options for mobility are far from exhausted. Today's freedom of movement can be preserved for Americans in the year 2000 without energy consumption greater than we used for transport in 1970

L-4-10-74

ENERGY CONSERVATION BEING PUSHED HARD.
West, T. Oil Gas J. 72, No. 10, 67-73 (1 Mar 1974).

Energy conservation is being practiced in petrochemical industries and teams have been established to plan the programs and projects. Dow Chemical, Du Pont, American Cyanamid, BASF Wyandotte, Union Carbide, Exxon Chemical, and Occidental are companies reporting energy-reduction programs in power generation, process changes, steam savings, using waste, waste stream sales, furnace and flue gas savings. (MCW)

Staff Report. A Technical Basis for Energy Conservation.
Federal Power Commission, Washington, D.C. Office of the
Chief Engineer. Apr 74, 57p FPC/OCE-2
PB-231 924/2WE PC\$3.75/MF\$1.45

A means for evaluating measures for coping with the nation's energy problems and for achieving fuel efficiency is presented. Correction of inefficiencies at the point of consumption of fuel and electric power offers one of the greatest and as yet unexploited opportunities for improving overall fuel efficiency. The report says that in the short-run, improved fuel efficiency offers a means for dealing with fuel shortage without severe economic disruption. In the long-run, with steeply rising fuel prices a virtual certainty, the report declares that improved fuel efficiency is an essential part of maintaining a productive, competitive industry, able to supply the goods and services which society requires.

Energy Conservation, It Benefits All of Us.
Federal Power Commission, Washington, D.C. Feb 74, 13p
PB-231 978/8WE PC\$3.00/MF\$1.45

This booklet has been prepared to help provide an understanding of the energy problem, to show why energy conservation is essential, and to indicate the actions individuals and organizations can undertake to conserve electricity and natural gas, which together account for half of the U.S. energy consumption.

HIGH-PERFORMANCE GLASSES FOR ENERGY-EFFICIENT BUILDINGS. Malarky, J. T. Prof. Eng.; 44: No. 2, 23-27 (Feb 1974).

Tinted glasses accomplish environmental control by means of selected metallic oxides added in small amounts to the basic soda-lime-silicate glass formula. The characteristics of a representative office building in Pittsburgh, Pa. were used to determine the effect of glass on energy consumption. Three architectural glasses were evaluated and it was concluded that glass in exterior walls saves energy during heating or cooling. Calculations were made for 1/4-in. clear glass, 1-in. bronze insulating glass, and 1-in. reflective insulating glass. Glass is also a good building material choice in regard to the amount of energy needed for its production. (MCW)

(ORNL-NSF-EP-66) ENERGY CONSERVATION AND THE ENVIRONMENT. Progress Report, December 31, 1973. (Oak Ridge National Lab., Tenn. (USA)). Mar 1974. Contract W-7405-eng-26. 76p. Dep., NTIS \$7.00.

Emphasis was mainly placed on opportunities for energy conservation in the transportation and residential sectors. Preliminary results for a highly disaggregated model of the TVA service area were obtained for the electricity demand growth. The research on policy alternatives in coal mining is discussed. The chapter on Energy Conservation Analysis contains sections on energy uses for automobiles, bicycles, and aircraft; total energy requirements of air transport; residential energy conservation; and energy use for food. From the discussion on Demand for Electricity, information is included on effect of rate structure; applicability of the national electric demand models to the TVA service area; data base and preliminary results in TVA area demand study; and communication and implementation of findings. Evaluation of alternative reclamation techniques, an overview on the role of coal, and implementation activities are discussed under Coal Mining and the Environment. Energy Information and program publications are included. (MCW)

SYSTEM OPTIMIZATION AND ENERGY CONSERVATION FOR LOS ANGELES MEGASTRUCTURE. Ayres, J. M.; Sun, T. Y. (Ayres and Hayakawa, Los Angeles). Heat., Piping Air Cond.; 46: No. 1, 60-63 (Jan 1974).

Broadway Plaza in Los Angeles covers 4.5 acres with shopping, office, and hotel facilities within a single structure. Emphasis was placed on system optimization, energy conservation, and life safety in the computer-aided design for the plaza. The entire structure is described with its environmental engineering in all areas. (McCW)

(CONF-740214-1) NATURE OF DEMAND GROWTH AND IMPLICATIONS FOR ENERGY CONSERVATION. Gill, G. S. (Oak Ridge National Lab., Tenn. (USA)). 1974. 11p. Dep. NTIS \$3.00.

From conference on energy conservation research; Warrenton, Virginia, USA (18 Feb 1974). The demand for electricity in the United States has been consistently growing at 7% per year for most of the post World War II years. If this trend were to persist, the demand for electricity in the year 2000 would be six times the 1970 level. This growth presents two major problems: the potential gaps between the supply of and demand for electricity and the growing stress on the quality of the environment. Research has accordingly been directed towards developing a methodology for an enhanced understanding of the nature of demand growth. Both constant and variable elasticity models provide useful information to the policy makers, public utilities, regulatory agencies, citizens groups, and scientific community for effectively dealing with the present and potential problems. (auth)

Energy Conservation and Waste Heat Utilization. A
Bibliography with Abstracts.
Edward J. Lehmann.

National Technical Information Service, Springfield, Va. Jul
74. 147p NTIS-WIN-74-051
COM-74-11138/6WE PC\$20.00/MF\$20.00

The bibliography contains 142 selected abstracts of research reports retrieved using the NTIS on-line search system--NTISearch. The report is divided into two sections dealing with energy conservation. In the first, 50 reports are presented which concern all aspects of energy conservation including topics such as reducing electricity demand, conservation policies, and the reduction of heating and automotive fuel consumption. The second section covers all aspects of recovering waste heat from power plants, buildings, and industrial water. These 90 reports include studies of total energy systems, waste heat boilers, and the use of power plant waste heat for irrigation, heating, sewage treatment, and desalination.

NINE WAYS TO BETTER FUEL MILEAGE.

D.L. Berry.
Automotive Engineering, v.82, no.8, Aug.1974,
p.51-55.

Although it began as a weekend diversion for staff engineers, the Shell Mileage Marathon soon became a serious challenge to technical ingenuity. One vehicle has already achieved 376.59 miles per gallon and 400 mpg is not far away. There's even some spin-off for the everyday driver in these energy-conscious times.

Leighton, Robert. THE ECONOMICS OF ENERGY: ALTERNATIVE STRATEGIES
FOR CONSERVING A DIMINISHING REGIONAL RESOURCE. New York, Tri-
State Regional Planning Commission, 1974. 15 p.

"The Energy Crisis—What Can We Do?" has just been published by Energy Conservation Research with the cooperation of the American Gas Association, American Petroleum Institute, and Edison Electric Institute. It is a comprehensive study of conservation measures that can be undertaken by the individual consumer, emphasizing the elimination of inefficiencies in automobile use and home heating. The guide can be obtained from Energy Conservation Research, 9 Birch Road, Malvern, Pa. 19355.

+++ An energy conservation check-off list prepared for Raytheon Company facilities but applicable to other companies and businesses is available without charge from the Office of Public Relations, Raytheon, Lexington, Mass. 02173. Telephone 617/862-6600 ext. 413.

"The Crunch," a 20-page illustrated handbook, has been published by Honeywell's Commercial Division. It is crammed with tested ideas on how to save on heating, cooling, lighting, and ventilating. It also tells how to schedule power loads and how to shed them to avoid high electrical-demand charges. Copies are available without charge from Honeywell branch offices or from Honeywell's Commercial Division, 2727 South Fourth Ave., Minneapolis, Minn. 55408.

"The Energy Crisis Challenge," a 60-page brochure from Dearborn Chemical Div., Chemed Corp., explains the three major energy wasters in boiler room operations and suggests remedies. It even contains tables and charts that permit the reader to calculate losses in his own plant. For a free copy contact Dearborn Chemical Div., Chemed Corp., Dept. BWT, 388 Genesee St., Lake Zurich, Ill. 60047.

1973

N74-15682# Committee on Government Operations (U. S. House).
CONSERVATION AND EFFICIENT USE OF ENERGY.
PART 1
Washington GPO 1973 469 p refs Hearings before Comm. on Govt. Operations and Comm. on Sci. and Astronaut. 93d Congr., 1st Sess., No. 14, 19 Jun. 1973 Prepared in cooperation with Comm. on Sci. and Astronaut.
Avail: SOD HC\$3.05

A Congressional hearing on the conservation and efficient use of energy resources is presented. The organization and functions of the Office of Energy Conservation are described. Current research and development projects being conducted by the government to conserve energy resources by increasing the efficiency of converting heat energy to electricity are explained. Improvements and developments in surface transportation systems for increased efficiency are reported. Specific research and development projects are defined to show the scope of the effort, the FY 1973 funding, and the proposed FY 1974 funding.
P.N.F.

CONSERVATION AND EFFICIENT USE OF ENERGY.
Part 3. Joint Hearings Before Certain Subcommittees of the Committees on Government Operations and Science and Astronautics, House of Representatives, Ninety-Third Congress, First Session, July 11, 1973. Washington, DC: Committees on Government Operations and Science and Astronautics (1973). 697p.

A comprehensive statement was issued at the hearings on the conservation and efficient use of energy by the Chairman of the President's Council on Environmental Quality. After noting the extraordinarily rapid growth rate of energy use in the U. S., energy use trends, the environmental impact of energy use, comparative effects of electric power systems, options for reducing environmental impact, improving production efficiency, and conservation in transportation, in residential and commercial sectors, and in the industrial sector are discussed. Other conservationists from many other facets of industry made statements. It is indicated that the importance of energy conservation can only be fully grasped when the present rate of energy growth is projected into the future. (MCW)

N74-15686# Committee on Science and Astronautics (U. S. House).
INDIVIDUAL ACTION FOR ENERGY CONSERVATION
Washington GPO Jun. 1973 8 p Presented to Comm. on Sci. and Astronaut. 93d Congr., 1st Sess., 31 May 1973
Avail: Subcomm. on Energy

Prompted by a concern for conserving the limited energy supplies, suggestions are given for saving money and using less energy. Ideas are presented for: driving and purchasing automobiles; cooling and heating residential homes; using home appliances; and vacationing.
K.M.M.

1973

N74-15688# Committee on Interior and Insular Affairs (U. S. Senate).
SUMMARY OF THE ENERGY CONSERVATION AND DEVELOPMENT RECOMMENDATIONS CONTAINED IN THE FINAL REPORT OF THE NATIONAL COMMISSION ON MATERIALS POLICY, JUNE 1973: A BACKGROUND PAPER
Washington GPO 1973 35 p refs Presented to Comm. on Interior and Insular Affairs, 93d Congr., 1st Sess., Jun. 1973 Prepared by Library of Congr.
Avail: SOD HC \$0.35 Domestic Post Paid or \$0.20 GPO Bookstore

A summary of the energy conservation and development recommendations was presented to the U.S. Congress pursuant to Senate Resolution 45. The summary was based on the final report of the National Commission on Materials Policy. The seven functions which are to be served by the national materials policy are defined. The major theme of the report is the need to strike a balance between producing goods and protecting the environment. A second theme is the need for a balance between the supply of materials and the demand for their use by increasing primary materials production. Specific recommendations are submitted for the following: (1) disposition of wastes, (2) development of energy sources, (3) land use, (4) water use, and (5) international aspects of the materials policy. The requirements for science and technology, research and development, and inventories of materials are included.
P.N.F.

1973

N74-14692# Committee on Commerce (U. S. Senate).
NATIONAL FUELS AND ENERGY CONSERVATION ACT OF 1973
Washington GPO 1973 177 p refs Rept. on S.2176 presented by Comm. on Com. at the 93d Congr., 1st Sess., 16 Nov. 1973
(S-Rept-93-526) Avail: US Capitol. Senate Document Room

The National Fuels and Energy Conservation Act of 1973 is reported. The purpose of the bill is to declare a national policy of conserving energy resources through more efficient conservation and use, to make energy conservation an integral part of all programs of the Federal Government, and to encourage an energy conservation ethic among American industry and the consuming public. The methods by which these goals are to be achieved are specified. Examples of energy conservation by various components of the national economy are provided. Author

73V37295 1973 ISS.00 1J163.4.06U54 1973 333.8 LC-73-87221
CITIZEN ACTION GUIDE TO ENERGY CONSERVATION.
UNITED STATES. CITIZENS' ADVISORY COMMITTEE ON ENVIRONMENTAL
QUALITY.

FOR SALE BY THE SUPT. OF DOCS., U.S. GOV. PRINT. OFF., WASHINGTON;
64 P. ILLUS. 26 CM.

\$1.75 COVER TITLE. BIBLIOGRAPHY P. 58.

LC ENERGY CONSERVATION -- UNITED STATES.

ADDED N#US***

MAIN-CORP TRACE-TITLE# CALIG 84-LC

1973

N74-14684# Interior Dept., Washington, D.C. Office of Energy
Conservation.

FEDERAL AGENCY ENERGY CONSERVATION Quarterly
Report. Jul. - Sep. 1973

Dec. 1973 13 p. ref.
(QR-1) Avail: NTIS HC \$3.00

On June 29, 1973, the President ordered the Federal government to achieve a 7 percent reduction in its anticipated energy consumption over the succeeding 12 months. While there are more than 80 departments and agencies within the Federal government, nearly all of the energy is consumed by the 11 cabinet departments and five large agencies. The focus of the effort has been in these 16 units. In all, a total of 20.8 percent savings in energy was made when compared to anticipated use during FY 1974. Monetary savings amounted to about \$160 million. The Department of Defense is the largest user of energy in the government (88 percent), and it effected the greatest savings, mostly in its diminished use of automotive and aviation fuels. Seven other agencies met or exceeded the goal. Author

N74-14687# Interior Dept., Washington, D.C. Office of Energy
Conservation.

FEDERAL ENERGY CONSERVATION Interim Report

Oct. 1973 33 p.

Avail: NTIS HC \$3.75

This interim report estimates total energy use in the sixteen major Federal agencies during Fiscal Year 1973. It will provide a baseline against which to measure progress in succeeding years. The sixteen largest agencies consumed 2.26 quadrillion British thermal units of energy in Fiscal Year 1973, of which about 60 percent was for vehicle and equipment operations and about 40 percent for building and facility lighting, heating and cooling. Specific actions being taken to achieve the targeted reduction in energy use during the current fiscal year are described. As expected, all agencies will seek to reduce lighting, heating and cooling, as these are the easiest to put into motion, monitor, and adjust as experiences dictate. A host of other ideas have also surfaced, however, including reduced travel and shifts to more energy-conservative ways to travel, employee participation through use of public transport, bicycles, and the like. Author

MAN WITH THE ENERGY ANSWERS.

T. Eilhoart.

New Scientist, Dec.13,1973, p.782,783,786.

Nicolaus Laing, a German Physicist with an outstanding record as an entrepreneur and innovator, claims to have prototypes which can reduce consumption of fossil fuels to less than a tenth of current predictions by 1990. Tim Eilhoart talked with him.

GASOLINE RATIONING AS A SOLUTION TO RESOURCE,
ENVIRONMENTAL AND URBAN PROBLEMS.

J.J. Musial and J.L. Stearns.

Intern. J. Environmental Studies, 1973, v.5, p.173-81.

Proposes that we begin exercising some controls over demand thru a permanent, planned gasoline rationing program.

ENOUGH ENERGY-IF RESOURCES ARE ALLOCATED RIGHT.
p.50-58.

CURBING THE NATIONS APPETITE FOR ENERGY. p.58,60.

Business Week, April 21, 1973.

ALUMINUM - VILLAIN OR HERO IN ENERGY CRISIS?

C. Norman Cochran.

SAE Automotive Engineering, v.81, no.6, June 1970,
p.57-61.

Expanding use of aluminum in transportation vehicles can make a significant contribution towards conserving the nation's critical energy supplies.

TITLE: Energy Conservation
CORPORATE AUTHOR: Concern Inc.
ADDRESS: 2233 Wisconsin Ave. NW, Washington, DC 20007

PUBLICATION DESCRIPTION: Concern Inc. Eco-tips
No. 5, 8 p.

PUBLICATION DATE: 1973, February
ABSTRACT: This pamphlet is an outline description of energy sources and methods of energy conservation. Sections deal with sources of energy, transportation, heating and cooling, household appliances, industry and recycling.
(JNC)

AVAILABILITY: Concern Inc., 2233 Wisconsin Ave.
NW, Washington, DC 20007 (\$7.50 per hundred)

END OF THE AMERICAN DREAM?

G. Chedd.

New Scientist, Nov.15,1973, p.473-474.

Nixon's dramatic appeal to the American nation last week to conserve energy could signal the beginnings of a serious re-evaluation of the country's traditional pattern of exponential energy growth.

ENERGY CONVERSION IN MODERN OFFICE BUILDINGS.

W.H. Correale.

J. Environmental Systems, v.3, no.4, Winter 1973,
p.307-316.

Emerging critical problems relating to the shortages of energy have fostered new inquiries into ways and means of reducing energy consumption in urban centers. The modern, high-rise office building in aggregate may consume as much as 20% of the total energy used in a large city and consequently is deserving of more careful analysis than has heretofore been given. A recent inquiry has verified the need for further study in depth of the apparent significant waste of energy in large office buildings.

AIRWEST DETAILS FUEL-SAVING PROCEDURES.

AW&ST, v.99, no.3, July 16,1973, p.34.

1973

N74-14688# National Bureau of Standards, Washington, D.C.
Inst. for Applied Technology.
ENERGY CONSERVATION THROUGH EFFECTIVE UTILIZATION

Charles A. Berg Feb. 1973 55 p refs
(NBSIR-73-102) Avail: NTIS HC \$4.75

In two major sectors of the economy (building services and industrial processes), accounting for approximately 75 percent of the total national energy consumption, energy utilization was found to be inefficient. It is estimated that in these two sectors, as much as 25 percent of the energy consumed annually by the nation as a whole may be lost through ineffective practices. Possible reasons for the existence of ineffective utilization are considered, and possible means of improving effectiveness of utilization are discussed. The levels of effort to promote effective utilization of energy are identified as: (1) the effective use of present fuels in present processes, (2) utilization of presently unused energy sources, and (3) more effective investment of energy in durable and maintainable products. Author

TITLE: Conservation

AUTHOR: Avramides, A.

CORPORATE AUTHOR: National Petroleum Council

PUBLICATION DESCRIPTION: Part of National Energy Priorities - A National Energy Policy for the Future, Proceedings of the 1973 Rocky Mountain Petroleum Economics Institute, p. 39-44

PUBLICATION DATE: 1973

ABSTRACT: A review is given of the National Petroleum Council's energy study with respect to energy conservation. Although a growing economy makes demands on energy supplies, it also provides technology to achieve environmental improvements. (JNC)

AVAILABILITY: Ms. Lyane Roll, Industrial Economics Div., Denver Research Institute, University of Denver, Denver, CO 80210
(\$7.00 prepaid for entire proceedings)

ENERGY CONSERVATION THROUGH EFFECTIVE UTILIZATION. Berg, C. A. (National Bureau of Standards, Washington, DC). Science; 181: No. 4095, 128-138(13 Jul 1973).

The ineffective utilization of energy in buildings and industrial processes constitutes a major component of the energy problems in the United States. Not only could the effectiveness of energy utilization be improved, but such improvement appears to be justifiable economically, especially when the costs of the alternative of expanding the national capacity to supply increasing energy demands are considered. The measures to improve effectiveness of energy utilization are basically technological in nature. However, at present, there does not exist an identifiable technological field concerned with energy conservation through effective utilization. Although techniques for this purpose exist and others can be developed, extant techniques have not been integrated and applied in rational field practice, and there is no disciplinary framework within which further developments might be made. (34 references) (auth)

1973

Energy alternatives for California: the current crisis. 2: Conservation of energy. RAND Corp., Santa Monica, Calif. DOWNS, P. D. DEC. 1973. 34 PAGES REFS. P-5156 AVAIL- THIS RC \$4.75

CALIFORNIA, CONSERVATION, ENERGY CONSUMPTION, ENERGY POLICY, GOVERNMENT/INDUSTRY RELATIONS, GRAPHS (CHARTS), RESOURCES, UTILIZATION
CS9 570-22995 0

TITLE: Summary of the Energy Conservation and Development Recommendations Contained in the Final Report of the National Commission on Materials Policy, June 1973

AUTHOR: Beard, O. P.

CORPORATE AUTHOR: Library of Congress, Congressional Research Service, Environmental Policy Division

PUBLICATION DESCRIPTION: Serial No. 93-16

(92-51), A Background Paper prepared pursuant to S. Res. 45, A National Fuels and Energy Policy Study, 30 p.

PUBLICATION DATE: 1973

SPONSOR: U.S. Senate, Committee on Interior and Insular Affairs

ABSTRACT: This committee print summarizes the energy-related recommendations contained in "Material Needs and the Environment Today and Tomorrow", the final report of the National Commission on Materials Policy, published in June, 1973. The recommendations include balancing the need to produce goods with the need to protect the environment; balancing supply and demand for materials through conservation, recycling, and greater efficiency; and recognizing the complex interrelationships among energy, materials, and the environment. (JNC)
AVAILABILITY: DDC 330.2 No. 5270-1195 \$4.55 domestic postpaid, \$4.20 CPO bookstore)

1973

Conservation via Effective Use of Energy at the Point of Consumption.

Charles A. Berg.

National Bureau of Standards, Washington, D.C. Inst. for Applied Technology. Apr 73. 38p NBSIR-73-202

COM-74-10479/SWE PCS:00/MFS1.45

The practices and equipment employed at the point of energy consumption in buildings and in industrial processes permit excessive consumption of energy. It is estimated that if full application of the economically justifiable technical improvements presently available were made to equipment and practices in buildings and industry, as much as 25 percent of the total primary fuel consumption in the U.S.A. could be conserved. The reasons why economically justifiable application of effective technology at the point of energy consumption has not been widely adopted in the past are considered. The needs to facilitate adoption of effective equipment and practices in the future are discussed. (Author)

1973

The Illinois Consumer's Role in Energy Conservation.
Clark W. Bullard, III.

Illinois Univ., Urbana. Center for Advanced Computation. 13
Jun 73. 36p CAC-78, NSF-RA/N-73-035
PB-228 004/8WE PC\$5.00/MF\$1.45

The Illinois contribution to the BNP is examined to determine the energy required to manufacture, deliver, and sell the goods and services which make up the State product. The analysis is based on a method for converting dollar expenditures to total energy requirements. It is shown that more energy is burned in Illinois than is mined, and still more is required to produce the goods and services sold in the Illinois marketplace. Thus, Illinois imports direct energy, in the form of oil and gas, and is also a net importer of indirect energy, that embodied in goods and services manufactured with energy burned in other states. (Modified author abstract)

N74-15890# Committee on Interior and Insular Affairs (U. S. Senate)

ENERGY CONSERVATION, PART 1

Washington GPO 1973 482 p refs Hearings pursuant to S. Res. 45 before Comm. on Interior and Insular Affairs. 93d Cong., 1st Sess., 22-23 Mar. 1973

Avail: Comm. on Interior and Insular Affairs

A Congressional hearing on the role of energy conservation in the National energy policy was conducted. The hearing assisted members of Congress and other interested parties in their understanding of the issues inherent in the formulation of a long-term National Energy Policy which assures the continued welfare of the Nation including balance growth safeguarding and enhancing the quality of the environment, and national security. The questions addressed in the hearings were directed toward:
(1) the general issue of energy conservation, (2) detailed questions and policy issues, (3) requirements of the transportation sector, (4) requirements of the residential/commercial sector, (5) requirements of the industrial sector, and (6) requirements of the electric utilities.
P.M.F.

N74-15822# Committee on Interior and Insular Affairs (U. S. Senate).

ENERGY CONSERVATION AND S. 2176, PART 2

Washington GPO 1973 845 p refs Hearing on S. 2176 before Comm. on Interior and Insular Affairs. 93d Cong., 1st Sess., 1 Aug. 1973

Avail: Comm. on Interior and Insular Affairs

Hearings are reported describing the role of energy conservation in national energy policy. Conservation in transportation, housing, and in the industrial sector are emphasized. Ways to educate consumers to use energy more efficiently especially regarding motor vehicles and home appliances are outlined.
S.K.W.

1973

TITLE: Conservation and Efficient Use of Energy
CORPORATE AUTHOR: U.S. House of Representatives,
Committee on Government Operations,
Conservation and Natural Resources
Subcommittee

PUBLICATION DESCRIPTION: Hearings held May 1 and 2, 1973, 112 P.

PUBLICATION DATE: 1973

ABSTRACT: These hearings were held to gain information on what can be done by government, industry, and individual consumers to conserve energy. Testimony was presented by the following people and their associates: Wilson Clark, Environmental Policy Center; Leo A. Daly, American Institute of Architects; S. David Freeman, Ford Foundation Energy Policy Project; Patrick J. Lucey, Governor of Wisconsin; Stewart L. Odell, Overview Corp. and former Secretary of the Interior; and Lee C. White, Consumer Federation of America. (RPG) AVAILABILITY: GPO (Bookstore \$3.55 or Domestic postpaid \$3.65)

Conservation and efficient use of energy: a state regulator's view Michigan Public Service Commission. BILLS, W. E. 1973 15 PAGES 22P. MAIL- \$15 NC \$4.00

ENERGY CONSERVATION, ENERGY POLICY, ENERGY DISTRIBUTION, ENERGY REQUIREMENTS, ENERGY SOURCES, REGULATIONS, UTILITIES
C03 F79-21606 9

1973

CONSERVATION: A POSITIVE POSITION. Clement, R. C. IEEE (Inst. Elec. Electron. Eng.) Spectrum, 10: No. 8, 44-47(Aug 1973).

Correlations exist between increasing consumption of electricity and the high-consumption society that exists in the last generation. The price tag of progress—rising pollution, deteriorating cities, the disappearance of amenities in the countryside, social unrest, and alienation—is discussed as seen by the engineers; view and those who refute it. In 1969, assumptions that had existed since WW II became useless. These observations were that prices would remain relatively constant, fuel would remain generally available, Government policy would remain relatively unchanged, and there would be gradual technological improvement in energy production. Environmentalists insist on a policy that requires the full economic and social costs of energy on the consumers of energy and the adequate environmental safeguards on the producers and distributors of this energy, the elimination of economic subsidies to energy industries for doing what small business does without in response to public demand for goods at a fair price; performance standards on the building industry and the manufacturers of energy-consuming equipment to eliminate the wasteful build-in obsolescence characteristic of so much production in the US today with the existing inefficiencies; and a shift in transportation policies from inefficient huge automobiles and intercity trucks and aircraft to more efficient railroads, buses. (MCW)

1973

TITLE: Transportation and Energy Conservation in the Pacific Northwest

AUTHOR: Dickinson, J.T.

CORPORATE AUTHOR: Washington State University

ADDRESS: Pullman, WA 99163

PUBLICATION DESCRIPTION: 31 p. report

PUBLICATION DATE: 1973, December

ABSTRACT: An economic analysis is made of the energy use in the transportation field in the states of Washington, Oregon, and Idaho. Using published data from various sources, estimates are made of the energy savings which are possible by several methods, including shift to smaller cars, urban mass transit, intercity mass transit, bus on pleasure driving, bus on vacation driving, bus on Sunday driving, reducing speed limits, and shift of methods of freight transport. (JMC)

AVAILABILITY: Environmental Research Center, Washington State University, Pullman, WA 99163 (no charge)

TITLE: Federal Agency Energy Conservation First Quarterly Report -- Fiscal Year 1978 (July - September 1973)

CORPORATE AUTHOR: Executive Office of the President, Federal Energy Office, Office of Energy Conservation

ADDRESS: Washington, DC 20240

PUBLICATION DESCRIPTION: 7 p. report, illustrations

PUBLICATION DATE: 1973, December

ABSTRACT: This is a detailed report of the energy conservation achieved by the 11 cabinet level departments plus 5 independent agencies, which together account for almost all of the energy use by the Federal Government. A saving of 21% was achieved over this period. (JMC)

Energy conservation what are the chances? J.H. Gibbons (Oak Ridge Nat. Lab., Tenn., USA). EASCON '73. Record, Washington, D.C., USA, 17-19 Sept. 1973 (New York, USA: IEEE 1973), p.90-4. The author discusses methods to decrease the rate of demand growth through more efficient energy use. Analysis of energy end-use and of the potential for energy conservation are discussed. (13 refs.)

1973

73-WA/Ener-1 **Power Reduction in Air Conditioning by Means of Off-Peak Operation and Cooldown Storage.** by J. C. Dudgey, General Electric Co., Lynn, Mass., and S. I. Freedman, RJ Energy Systems, Inc. So. Braintree, Mass. (To be published in Trans. ASME--J. of Engrg. for Power.)

An original air-conditioning system was developed which requires considerably less power than conventional systems while providing identical cooling and dehumidification. The 50 percent (depending on application) power reduction is accomplished by off-peak compressor operation and storage of chilled water.

The full cooling and dehumidification is accomplished by means of a new thermodynamic cycle involving two evaporators with an intermediate condenser operating with the stored chilled water.

The system was built, instrumented, and operated reliably. Evaluation of performance data confirmed the theory and verified the power reduction, cooling, and dehumidification performance calculations.

1973

ENERGY CONSERVATION BY REBESSEN: WATTS GO UP THE CHIMNEY, THROUGH WINDOWS AND WALLS, AND ARE DISSIPATED UNNECESSARILY IN APPLIANCES. Friedlander, G. D. IEEE (Inst. Elec. Electron. Eng.), Spectrum; 10: No. 11, 36-43(Nov 1973).

The responsibility of energy conservation will rely on the cooperation of all who produce and consume energy from the mining and petroleum recovery to industry, commerce, and domestic consumer. Canada has announced export reduction in order to keep its own reserves, and with the cessation of Arab oil imports conservation must be the top priority if the U. S. is not to become a "have not" nation. Energy features of building design and energy-conserving techniques for buildings are discussed. A description is given for the Westinghouse Electric Corporation's and Pennsylvania Power and Light Company's energy-saving model residences. A discussion on the basic fuel and energy system efficiencies indicates that gas-powered appliances consume more direct energy than similar electrical equipment. Electricity produced from natural gas is inefficient. Gas lamps are still in use in the U. S. and each of these lamps requires about 20 times more energy than its electrical equivalent. The economies in natural-gas savings that could be attained by replacing gas lamps with incandescent bulbs would be enough to heat more than 600,000 homes yearly. (MCW)

153

OL-129,989

1973

THE POTENTIAL FOR ENERGY CONSERVATION. SUBSTITUTION FOR SCARCER FUELS. A Staff Study. (Period covered: 1973-1985). Jan. 1973. 54p. 6 apps.

Executive Office of the President
Office of Emergency Preparedness

Energy conservation
Power sources

Fuels, Oil

Coal

(Coal for oil and gas)

129,652/18
L-9-28-73

TITLE: Conservation of Natural Resources -- The Electric Energy Conversion and Consumption Processes, Order No. 495, Promulgating Statement of Policy on Measures to Implement Conservation of Natural Resources

CORPORATE AUTHOR: Federal Power Commission
ADDRESS: Washington, DC 20426

PUBLICATION DESCRIPTION: Docket No. R-454, 14 p., appendix

PUBLICATION DATE: 1973, November 13

ABSTRACT: This is a presentation of the rationale for an addition, entitled "Conservation of Natural Resources", to the General Policy and Interpretations - General Rules. The text of the addition is given. It asks all electric utilities to report to the Federal Power Commission, annually, all efforts, including research programs, designed to conserve natural resources. (JNC)

ENERGY: SHORTAGES LOOM, BUT CONSERVATION LAGS. Holden, C. Science; 190: No. 4091, 1155-1158(15 Jun 1973).

Long-range energy conservation policies are needed in order to preserve the environment, but immediate steps are needed until new, clean power sources become available. Legislation and interest are lagging. The steps that could be taken to reduce fuel consumption and make electricity more efficient have been delineated many times: build automobiles that operate on lower horsepower, develop urban mass transit, shift freight from plane and trucks to rails and waterways, insulate buildings, design new buildings for maximum use of heating and cooling systems, set minimum efficiency requirements for power-consuming products, save natural gas for uses other than production of electricity, recycle waste, and change power rates to encourage efficiency. (MCW)

EFFICIENCY OF ENERGY USE IN THE UNITED STATES.

E. Hirst and J.C. Moyers.

Science, v.179, Mar.30,1973, p.1299-1304.

Transportation, space heating, and air conditioning provide opportunities for large energy savings.

TITLE: Energy Conservation in the Steel Industry - It Must Be Done
AUTHOR: Hovis, J.E.
CORPORATE AUTHOR: Bloom Engineering Co.
ADDRESS: Morning and Curry Roads, Pittsburgh, PA 15236

PUBLICATION DESCRIPTION: Industrial Gas, p. 9-14
PUBLICATION DATE: 1973, July
ABSTRACT: In steel mills in which natural gas is used in strip mill reheating furnaces and in soaking pits it is calculated that up to 25% fuel savings can be achieved with very little effort. More savings would result from a more intensive effort in this direction. One person, high in the organizational level should be in charge of energy conservation throughout the plant, with authority to institute corrective measures when necessary. (JNC)

TRANSPORTATION ENERGY USE AND CONSERVATION POTENTIAL. Hirst, E. (Oak Ridge National Lab., TN). Bell. At. Sci.; 29: No. 9, 38-42(Nov 1973).

Traffic, energy consumption, and energy intensiveness for inter-city freight and passenger traffic and urban passenger traffic are discussed. Transportation of people and goods consumes one-fourth of the total U. S. energy budget. Ninety percent of the world oil supply will have been consumed by about 2025 and ninety percent of U. S. oil reserves within 30 years. U. S. transportation is almost entirely dependent on oil as a fuel. Exploration, production, transportation, refining, and use of petroleum present serious environmental problems. Transportation contributes to a number of other environmental problems including urban congestion, inefficient land use, and noise. These facts support the urgent need for an examination of transportation energy use. (MCW)

1973

N74-17663 Joint Publications Research Service, Arlington, Va.
ROLE OF THERMOENERGETIC RESEARCH IN SAVING FUEL c33

Teofil Popovici and D. Marian *In its Transl. on Eastern Europe Sci. Affairs*, No. 383 (JPRS-61101) 30 Jan. 1974 p 24-26
 Transl. into ENGLISH from Romania Libera (Bucarest), 18 Nov. 1973 2 p (For availability see N74-17661 08-34)

A question and answer interview with the director of the Romanian Research and Design Institute for Thermoenergetic Equipment is reported. The interview involves proposals of concrete methods by which researchers and designers of thermoenergetic equipment can help to better use the fuel in the national economy.
 Author

N74-18724 #

(NBS-TN-789) **TECHNICAL OPTIONS FOR ENERGY CONSERVATION IN BUILDINGS**. Final Report. (National Bureau of Standards, Washington, D. C. (USA)). Jul 1973. 184p. GPO \$2.00.

The report provides references material on the technical options for energy conservation in buildings. It was prepared for the National Conference of States for Building Codes and Standards-National Bureau of Standards Joint Emergency Workshop on Energy Conservation in Buildings held at the U. S. Department of Commerce in Washington, D. C. on June 19, 1973. Actions described pertinent to existing buildings include: summer cooling, winter heating, and other energy conserving features—i.e., insulation, fenestration, lighting, appliances, domestic hot water, and human comfort. Suggested actions include those that can be accomplished voluntarily or without expense, and also actions that require some modest effort or expense on the part of the building owner or occupant. Regarding new buildings, energy conservation actions are described that deal with building design and mechanical systems. (auth)

N74-18677# RAND Corp., Santa Monica, Calif.
ENERGY CONSERVATION IN PUBLIC AND COMMERCIAL BUILDINGS

Richard G. Salter and Deane N. Morris Oct. 1973 61 p
 Sponsored by NSF (P-5093) Avail: NTIS HC \$5.25

A discussion is presented of the preliminary results of an ongoing study of the use of energy in public and commercial buildings. The effects of building location, design and operation alternatives are developed, together with initial estimates of the conservation potential in the sector.
 Author

1973

N74-17800# Environmental Protection Agency, Washington, D.C. Office of Research and Monitoring.

ENERGY CONSERVATION STRATEGIES

Marquis R. Seidel, Steven E. Plotkin, and Robert O. Rect Jul. 1973 122 p. refs

(PB-224493/7GA: EPA-R5-73-021) Avail: NTIS MF \$1.45; SOD HC \$1.25 as EP1.23/3-73-021 CSCL 21D

Strategies for reducing national energy demands are examined. It is necessary to find out, for each potential energy saving, how much energy is involved and how costly the alternatives would be. Many users get much of their energy at relatively low prices, and are thus encouraged to waste it; the economist calls this price distortion, a form of market failure. The study analyzes the kinds of market failure which seem to cause the present energy crisis, the kinds of government action which could rectify these failures, and the likely response of the economy to moderate price increases. Numerous actions, some large and some small, would be required to restore a more efficient functioning of the market for energy. In an efficient market, energy price increases of 25% would prompt a halving of the growth of energy demand; through 1990, energy needs would grow 40% rather than the 100% projected at current prices.

Author (GRA)

ENERGY CONSERVATION.

G.A. Lincoln.

Science, v.180, Apr.13,1973, p.155-162.

CN-129,719 Conservation Foundation

HIDDEN WASTE. POTENTIALS FOR ENERGY CONSERVATION.

David B. Iarge. May 1973.

ENERGY POTENTIAL OF CONSERVATION.

ON LIFTING OIL IMPORT QUOTAS.

AND ON THE CONSERVATION OF FUEL.

GAS CONSUMPTION DOWN?

POWER SITING POLICY.

Technology Review, May 1973, p.47-50.

1973

N74-15667 California Inst. of Tech., Pasadena. Environmental Quality Lab.
TIME FACTORS IN SLOWING DOWN THE RATE OF GROWTH OF DEMAND FOR PRIMARY ENERGY IN THE UNITED STATES
 Lester Lees and Mingin Philip Lo 1 Jun. 1973 35 p refs
 (Grant NSF GI-29726)
 (EOL-7) Copyright. Avail: Issuing Activity

The time scales involved in slowing down the rate of growth of primary energy consumption in the U.S. as one component of an overall energy/environment strategy designed to limit the required volume of energy imports from overseas are discussed. Two important energy-consuming sectors of the economy are chosen as illustrative examples: (1) the automobile as a total system (25%); (2) space heating, air conditioning and water heating in the residential sector (22%). These two components of an energy-conserving policy taken together would bring the growth rate in U.S. primary energy demand down from its present rate of 4.2% per year to about 2.8% per year by 1985. Reductions in the annual growth rate of the remaining 50% of U.S. primary energy consumption that seem quite feasible would bring the overall growth rate down to about 2.5% per year by 1985. If reductions in growth rate of this magnitude could in fact be achieved, energy imports would peak in the mid-1980s at a level no higher than about 80% above the present (1973) volume of imports. Incentives and disincentives designed to bring about this slowdown in the rate of U.S. energy consumption are discussed.

Author

1973

(TID-24336) **POTENTIAL FOR ENERGY CONSERVATION THROUGH INCREASED EFFICIENCY OF USE.** Hirst, E.; Moyers, J. C. (Oak Ridge National Lab., Tenn.). 1973. 32p.
 Dep. NTIS \$3.25.

Opportunities exist for significantly increasing the efficiency with which energy is used in the United States. This paper discusses such opportunities for (a) the transportation sector (shifts from energy-intensive modes to energy-efficient modes, increased use of existing equipment, and technological changes to increase vehicle energy efficiency) and (b) the household sector (additional building insulation, electric heat pumps rather than electric-resistance heating, energy-efficient air conditioners, and addition of insulation of water heaters). Such energy efficiency improvements may require institutional and social changes, but technologies are generally available to implement such strategies. The benefits to the nation in terms of energy conservation, reduced reliance on energy imports and improved balance of payments, reduced adverse environmental impacts, lower dollar costs, and a return to a more conservative resource-use ethic are potentially large. Policies to achieve such goals would involve some life-style changes and important institutional decisions, but they do not imply a return to "caves and candles."

see also: Environmental Systems, v.3, no.2,
 Summer 1973, p.153-169.

1973

N73-31990*# National Aeronautics and Space Administration. Goddard Space Flight Center. Greenbelt, Md.
ENERGY CONSERVATION ALTERNATIVES TO NUCLEAR POWER. A CASE STUDY

Robert F. Mueller Jul. 1973 36 p refs
 (NASA-TM-X-70468; X-644-73-205) Avail: NTIS HC \$4.00
 CSCL 10A

It is demonstrated that electric resistance heating and commercial lighting represent the greatest demand factors on the projected increase in electrical generating capacity. By use of conservative assumptions a quantity of electrical generating capacity in excess of that of a proposed nuclear power plant or 2,200 megawatts, can be saved chiefly through the avoidance of electric resistance heating and the institution of greater lighting efficiency. Many additional and alternative savings of energy and generating capacity could also result from such strategies as total energy systems and solar heating and air conditioning.

Author

S-433

THREE HUNDRED HINTS TO SAVE ENERGY.

John Muller.

Congressional Record - Senate, Oct.30,1973,
 p.S.19594-S.19598.

1973

N74-18806# RAND Corp., Santa Monica, Calif.
THE POTENTIAL FOR ENERGY CONSERVATION IN COMMERCIAL AIR TRANSPORT

James J. Much Oct. 1973 90 p refs
 (Grant NSF GI-44)

(R-1360-NSF) Avail: NTIS HC \$7.50

The potential is examined for reducing the energy requirements of the U.S. commercial airlines, with emphasis on the certificated-route air carriers. Measures stressed are independent of the level of traffic demand. They are intended to reduce energy requirements by decreasing the energy intensity of air transport. The possibility is examined of substituting more efficient transport modes for aviation in short-haul routes and the attendant net energy savings is assessed. Measures that yield benefits in both the short and long term are considered and their conservation potentials are quantified relative to present and future energy requirements. The results should be of interest to those involved in airline activities, including governmental regulatory and policymaking bodies, industry groups, and the airlines themselves.

Author

153

74V10706 1973 ISS 00 TJJ162.2.H95 333.8 LC-73-603697 SOD Y
4.CJ3/2 EN2

A/HYMAN, BARRY I. A/1937-
INITIATIVES IN ENERGY CONSERVATION: STAFF REPORT PREPARED BY BARRY
I. HYMAN FOR THE COMMITTEE ON COMMERCE, UNITED STATES SENATE.
U.S. GOVT. PRINT. OFF. WASHINGTON, V. 43 P. ILLS. 24 CM.
\$0.50 AT HEAD OF TITLE 93D CONGRESS, 1ST SESSION. COMMITTEE PRINT.
INCLUDES BIBLIOGRAPHICAL REFERENCES.
LC ENERGY CONSERVATION.
ADDED UNITED STATES. CONGRESS. SENATE. COMMITTEE ON COMMERCE.
MAIN-AUTH TRACE-CORP*TITL* CAILG BY-LC

74N72439 73/C3/00 56 PAGES UNCLASSIFIED DOCUMENT
IMPACT OF IMPROVED THERMAL PERFORMANCE IN CONSERVING ENERGY
NATIONAL MINERAL WOOL INSULATION ASSOCIATION, INC., NEW YORK.
AVAIL. NTIS
/*BUILDINGS/*THERMAL INSULATION/ ENERGY CONSUMPTION/ THERMAL ENERGY

1973

ENERGY CONSERVATION AWARDS FOR 1973. Power.
117. No. 11, 21-30(Nov 1973).

Dow Chemical was awarded a citation for energy conservation in 1973 for improvement of industrial power- and steam-generation cycles, and day-to-day surveillance of Btu consumption, in both power and process plants. Moore Products Co. in Philadelphia won the award when it moved to a new plant stressing the preservation of the local ecology and creating a favorable corporate image and assuring a better working environment for its employees by installing a two-stage cascade air-source heat pump capable of providing both heating and cooling simultaneously. Standard Oil of California's Richmond plant applied a steam-trap and steam-leak program with a reduction in steam demand by 250,000 lb/h with a fuel savings of 386,000 bbl/yr. The energy conservation program at Chevrolet-Livonia involved small changes such as the installation of a timer to turn off fan-room lights after two hours, the compressed air-pressure reduced to 90 from 105 psi, and some spray-washer nozzles delivering 2.8 gpm instead of 10, to win the citation. The Public Service Dept. of Burbank, Ca., added a 23-MW gas turbine with a heat-recovery steam generator to its generating system resulting in a combined heat rate of 9700 Btu/kWh compared with 11,000 Btu/kWh originally. (MCW)

TITLE: Energy Conservation in Public and Commercial Buildings
AUTHOR: Salter, R.G.; Morris, D.G.
CORPORATE AUTHOR: Rand Corp.
ADDRESS: Santa Monica, CA 90404
PUBLICATION DESCRIPTION: Rand Paper No. P-5093, 19 p.
PUBLICATION DATE: 1973, October
SPONSOR: National Science Foundation, RAMP Program
ABSTRACT: A discussion of the preliminary results of an ongoing study of the use of energy in public and commercial buildings is presented. The effects of building location, design and operation alternatives are developed, together with initial estimates of the conservation potential in the sector. The work is part of Rand's energy conservation work for the National Science Foundation.

157

1973

TITLE: Local Governmental Approaches to Energy Conservation

CORPORATE AUTHOR: Public Technology Inc.;

International City Management Association

ADDRESS: ICMA, 1140 Connecticut Ave. NW, Washington, DC 20036

PUBLICATION DESCRIPTION: 33 p. report, 3 p. of references

PUBLICATION DATE: 1973, December

ABSTRACT: This report covers three areas. Some of the causes of the current energy shortage are presented. Specific steps that can be taken in city and local government operation to reduce energy use are given. Sources of assistance and information are listed. (JMC)

(COM-73-50799-8-GA) SEVEN WAYS TO REDUCE FUEL CONSUMPTION IN HOUSEHOLD HEATING THROUGH ENERGY CONSERVATION. Knauer, V.; Kushner, L. M. (National Bureau of Standards, Washington, D. C. (USA)). Dec 1972. 12p. GPO \$0.35.

Increasing demand for natural gas, No. 2 heating oil, low-sulfur residual fuel oil, low sulfur bituminous coal, and electricity in the United States is imposing great pressures on available supplies. Conservation in the use of fuel and energy can reduce these pressures on demand, and at the same time provide the additional benefit of a reduction in environmental pollution. Practical ways by which one can conserve are: reset thermostat to lowest acceptable setting, such as two or three degrees below usual setting; service oil burners regularly (including replacement of filters) and turn off heat supply in unused rooms; keep draperies, shades and shutters closed except when needed for light; reduce the consumption of electricity during late afternoon and early evening periods; and improve insulation in attics and around doors and windows. (GRA)

U.S. Congress. House. Committee on Government Operations. Conservation and Natural Resources Subcommittee. CONSERVATION AND EFFICIENT USE OF ENERGY. JOINT HEARINGS before certain Subcommittees of the Committees on Government Operations and Science and Astronautics, House of Representatives, Ninety-third Congress, First Session. Washington, U.S. Govt. Print. Off., 1973. 463 p. 4 v. in 2. (1952 p.)

Hearings held June 19, 1973-July 12, 1973.

ENERGY AND WELL BEING.

A.B. Makhijani and A.J. Lichtenberg.
Environment, v.14, no.5, June 1972, p.10-18.

Since the utilization of energy and mineral resources has both provided us with diverse necessities and comforts and contributed to the deterioration of the environment, an evaluation of the degree of efficiency in the use of energy and materials is useful.

N74-21820# Committee on Interior and Insular Affairs (U. S. Senate).

CONSERVATION OF ENERGY

Washington GPO 1972 121 p refs Presented to Comm. on Interior and Insular Affairs. 92d Congr., 2d Sess., 1 Aug. 1972 Prepared by Library of Congr.

Avail: SOD HC \$0.50

The following topics relating to the conservation of energy resources are discussed. (1) The dependence of the United States on foreign supplies of oil and gas, and the extent to which energy conservation can provide greater national security through the reduction of imports. (2) The economic and technical feasibility of extending the use of available fuel reserves over a longer period of time through more efficient use of production and controls. (3) The consequences of a comprehensive federal program for energy conservation, considering the fact that existing policy is based on the premise that federal and state regulations should encourage industry to meet whatever demands are created in the marketplace. (4) The extent to which advances in finding new energy sources, i.e. solar, breeder, or controlled thermonuclear, will lessen the need for energy conservation. Author

74N71352 72/04/00 56 PAGES UNCLASSIFIED DOCUMENT
 IMPACT OF IMPROVED THERMAL PERFORMANCE IN CONSERVING ENERGY
 NATIONAL MINERAL WOOL INSULATION ASSOCIATION, INC., NEW YORK.
 AVAIL. NTIS

/#CONSERVATION/*ENERGY POLICY/*GOVERNMENTS/*THERMAL ENERGY/ AIR
 CONDITIONING/ BUILDINGS/ ENERGY CONSUMPTION/ ENVIRONMENTAL ENGINEERING/
 HEATING

1972

1972

TITLE: Using Gas More Efficiently
 AUTHOR: Murphy, G.L.
 CORPORATE AUTHOR: Consumers Power Co.
 ADDRESS: 212 West Michigan Ave., Jackson, MI 49201
 PUBLICATION DESCRIPTION: Industrial Gas, 52, 11-16
 PUBLICATION DATE: 1972, November
 ABSTRACT: This is a description of several instances in which plants have been able to reduce the use of natural gas by common-sense techniques. There was an economic advantage in each case. (JMC)

TITLE: Energy: Tomorrow Starts Today
 AUTHOR: Spaulding, J.
 CORPORATE AUTHOR: University of California, Berkeley
 ADDRESS: Berkeley, CA
 PUBLICATION DESCRIPTION: Sierra Club Bulletin, December 1972, 5 p.
 PUBLICATION DATE: 1972
 ABSTRACT: Much can be done to relieve the current energy crisis by simple conservation of energy methods. Estimates of the amount of fuel which can be saved by each of several techniques have been made by the federal government and other research organizations. (JMC)
 AVAILABILITY: Sierra Club, 1050 Mills Tower, San Francisco, CA 94104

TITLE: Conservation of Energy
 AUTHOR: Perry, H. Library of Congress.
 CORPORATE AUTHOR: Congressional Research Service; U.S. Senate, Committee on Interior and Insular Affairs
 PUBLICATION DESCRIPTION: Serial No. 92-18, Report prepared at the request of Henry M. Jackson, Chairman, Committee on Interior and Insular Affairs, U.S. Senate pursuant to S. Res. 45, A National Fuels and Energy Policy Study, 114 p.
 PUBLICATION DATE: 1972, August
 ABSTRACT: The principal theme of this report is that energy conservation and increased energy efficiency are important issues in resolving present and future energy needs and worthy of special attention in the formulation of national energy policy. An effort has been made to develop statistical data on these subjects and to outline some of the relevant arguments which have appeared in recent literature, hearings, and contractual studies. The report is organized into five major sections, as follows: Part I draws on recent writings which discuss energy as a scarce commodity and suggest policies that

TITLE: Conservation of Energy: The Potential for More Efficient Use
 AUTHOR: Hanson, A.L.
 CORPORATE AUTHOR: American Association for the Advancement of Science
 ADDRESS: 1515 Massachusetts Ave. NW., Washington, D.C. 20005
 PUBLICATION DESCRIPTION: Science, 178(4065), 1079-1081
 PUBLICATION DATE: 1972, December 8
 ABSTRACT: Ways of conserving energy are discussed, including more insulation in homes, more efficient heating and air conditioning equipment, solar heating and cooling, improved architectural design of high-rise buildings, improved efficiency of electric power generation, and changing modes of transportation. (HPC)

1973

ENERGY CONSERVATION: Statements, testimony and exhibits, including the full text of several recent research reports, on methods of reducing excess energy consumption. 809 pages. Single copies free. (Hearings--Conservation and Efficient Use of Energy, available from Committee on Science and Astronautics, Rm. 2391 Rayburn House Office Bldg., Wash., D.C. 20515.)

1973

(WASH-1281-12) END-USE ENERGY CONSERVATION. Subpanel Report XII Used in Preparing the AEC Chairman's Report to the President. Gibbons, J. H. (USAEC, Washington, D. C.). 1973. 226p. Dep. NTIS \$14.50.

The goal of the proposed energy conservation R and D program is to decrease the rate of growth in demand for energy and certain fuels and to achieve this decrease while maintaining an acceptable standard of living and environment, under conditions of minimal social and economic dislocation. This program will concentrate on opportunities for effective conservation of energy in the end-use sectors. Major increases in efficiency can be attained through improvement of end-use technologies, better material resource management, substitution of time and materials for energy, and alteration of lifestyles. In developing the program, end-use was divided into three main sectors (transportation, buildings, and industry) in order to inventory the opportunities for saving energy and to define mechanisms for allocating R and D resources. For technical reasons two more research sectors were added (integrated utility systems, and cross-sectoral studies). R and D resources applied to a given sector should generally reflect the magnitude of energy used in each sector multiplied by the potential energy savings in that sector. Obviously, there are additional factors that must be considered in determining research priorities. These include growth rate, role of federal versus private resources, and the extent of research opportunities. The "minimum" program developed by the panel is estimated to ensure a 15% savings before 2000. (LMT)

N74-20654*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.
AERONAUTICAL FUEL CONSERVATION POSSIBILITIES
FOR ADVANCED SUBSONIC TRANSPORTS
Albert L. Braslow and Allen H. Whitehead, Jr. 20 Dec. 1973
15 p

(NASA-TM-X-71927) Avail: NTIS HC \$4.00 CSCL 01C

The anticipated growth of air transportation is in danger of being constrained by increased prices and insecure sources of petroleum-based fuel. Fuel-conservation possibilities attainable through the application of advances in aeronautical technology to aircraft design are identified with the intent of stimulating NASA R and T and systems-study activities in the various disciplinary areas. The material includes drag reduction, weight reduction; increased efficiency of main and auxiliary power systems; unconventional air transport of cargo; and operational changes.

Author

N-140,010 Department of Transportation DOT-OST-TST-14

RESEARCH AND DEVELOPMENT OPPORTUNITIES FOR IMPROVED TRANSPORTATION ENERGY USAGE. (Prepared by the Transportation Energy Panel). Apr. 1973.

PB 220 612

1972-

TK
2896
1 55
1972

N74-16617# Swiss Inst. of Meteorology, Zurich.
THE EFFECT OF SHAPE AND ORIENTATION ON THE RADIATION IMPACT ON BUILDINGS
Peter Valko Dec. 1972 14 p refs Presented at CIB/WMO Colloq. on Building Climatology "Teaching the Teachers", Stockholm, Sep. 1972
(Rept-33) Avail: NTIS HC \$3.00

Building planning needs suitable information on radiation conditions, especially with respect to air-conditioning and daylight design. A survey on the origin and preparation of the data used is presented, and the significance of the diffuse component of the total radiation impact is emphasized. The adaptation of the irradiation functions is demonstrated for summer and winter conditions at 0 m altitude for the geographic latitude of 47 deg N. Numerical examples in cases of rectangular and cylindrical buildings illustrate daily and hourly radiation load changes against variation of building shape and facade orientation. Author

CN-129,413

TITLE: The Potential for Energy Conservation
CORPORATE AUTHOR: Executive Office of the President, Office of Emergency Preparedness
PUBLICATION DESCRIPTION: 260 t.
PUBLICATION DATE: 1972, October

ABSTRACT: This study suggests that energy conservation measures can reduce U.S. energy demand by 1580 Btu as much as the equivalent of 7.3 million b/d of oil (equal to about two-thirds reflected oil imports for that year). The most significant realizable measures to effect conservation are: a) improved insulation in homes, b) adoption of more efficient air conditioning systems, c) shift to intercity freight from highway to rail, intercity passengers from air to ground travel and urban passengers from automobiles to mass transit and freight consolidation in urban freight movement and d) introduction of more efficient industrial processes and equipment. (auth)

AVAILABILITY: GFC, Stock No. 3102-00009 (\$2.00)

N74-16616# Swiss Inst. of Meteorology, Zurich.
USE OF CLIMATOLOGICAL DATA IN BUILDING DESIGN WITH RESPECT TO ECONOMY
Peter Valko Dec. 1972 21 p refs Presented at CIB/WMO Colloq. on Building Climatology "Teaching the Teachers", Stockholm, Sep. 1972
(Rept-34) Avail: NTIS HC \$3.25

The building with its various planning and operational processes is considered a weather sensitive economic system. The impact of weather and climate affects the economic output of building enterprises. By using suitable design weather information in decision making, economic gain may be expected. Published benefit figures are of the order of 0.5 per cent of the total production of the construction industry, while for heating and air-conditioning several times higher relative benefits may be expected. Author

Intersociety Energy Conversion Engineering Conference, 7th, San Diego, Calif., 1972.
Proceedings. Washington, D. C., American Chemical Society, 1972.
1533 p. illus. 28 cm.

The Role of the New York City Government in Energy Conservation, C. W. Lawrence
P. 1269 -

1971

TITLE: Buildings That Save a Watt, and More
CORPORATE AUTHOR: Progressive Architecture, Reinhold Publishing Corp.
ADDRESS: 25 Sullivan St., Westwood, NJ 07695
PUBLICATION DESCRIPTION: Progressive Architecture, 108-111

PUBLICATION DATE: 1971, October
ABSTRACT: Buildings can be designed to allow for interior comfort and reduce the demand for energy. Shade trees, heat absorbing glass, and insulation are among the devices suggested to conserve energy. The shape and location of a building are also important. Three buildings are described to illustrate energy saving design. Twenty-one ways to save money and energy in buildings are listed.. (MPC)

TITLE: Available Now: Systems That Save Energy
CORPORATE AUTHOR: Progressive Architecture, Reinhold Publishing Corp.
ADDRESS: 25 Sullivan St., Westwood, NJ 07695
PUBLICATION DESCRIPTION: Progressive Architecture, 78-86

PUBLICATION DATE: 1971, October
ABSTRACT: Energy conservation can be obtained in buildings through better electrical and mechanical design. The advantages and disadvantages of a number of heating, cooling, and ventilating systems are discussed. Other methods of conserving energy include reevaluating illumination standards, more efficient lighting, compensation of power factors in induction type motors, heat recovery systems (including heat from lighting), plumbng systems that use less materials, use of heat pumps, and use of total energy systems. (MPC)

CN-129,951

1971

THE VALUE OF THERMAL INSULATION IN RESIDENTIAL
CONSTRUCTION: ECONOMICS AND THE CONSERVATION OF
ENERGY. John C. Moyers. (ORNL-NEF Environmental
Program). Dec. 1971. 100p.

Oak Ridge National Lab.
Contract W-7405-eng-26

ORNL-NEF-EP-9

Materials, Insulating
Buildings
Economics
Energy conservation

L-9-18-73
LRC 73-160

II. ENERGY AND POWER SOURCES

A. GENERAL



May 1974
Volume 6, Number 5

GOVERNMENT EXECUTIVE

ENERGY: A comprehensive look at the short term and long range aspects of a permanent national problem. Prepared under the direction of Associate Editor Samuel Stafford with artwork, cover and inside pages, by Graphics Director Jim Sturman.



Energy R&D

National energy policy is needed.

Sen. Jackson on Energy

Providing energy is an international challenge.

Total Energy Systems

"What's needed is some kind of partnership."

Mass Transit

Rohr's Raynes proposes \$77 billion, 16 year commitment.

The Oilman and the Frog

Texaco's Board Chairman looks at the energy question.

Energy and the Oceans

Will the Administration move before it's too late?

Offshore Nuclear Systems

Jacksonville, Fla. turns out floating nuclear plants.

New Contender in Nuclear Race

General Atomic builds plant in Colorado.

Solar Energy

Potential for the future.

Fuel Cells

Another space program spinoff benefit.

Power Pipeline

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39

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**ENERGY CRISIS FUELS RESEARCH
TO DEVELOP ALTERNATIVE POWER
SOURCES.** Three methods for producing power are
briefly reviewed, namely, high-power fuel cells, solar
power, and hydrogasification of cow manure.

Bond, John EDN v 19 n 3 Feb 5 1974 p 24-26.

Energy and Superconductivity.
National Bureau of Standards, Boulder, Colo. Cryogenic
Data Center. 20 Mar 74, 36p B-1153
COM-74-10713/7WE PC\$7.00/MF\$7.00

Contents: Generators, motors, transmission lines, transfor-
mers, thermonuclear fusion, MHD, magnets, miscellaneous
applications, refrigeration, patents, and reviews.

POWER/ENERGY: PROBLEMS AND PROGRESS.

G.D. Friedlander.

IEEE Spectrum, v.11, no.1, Jan.1974, p.60-65.

The power industry will attempt to generate and deliver over
two times the amount of power over the next ten years, but with
diminishing supplies of fossil fuels and with the added concern of
the environmentalists, massive changes in technology are re-
quired. A review is given of alternative methods being studied to
alleviate the energy crunch. Construction data of reactors in the
U. S. are tabulated. The fuel/energy equation for the U. S., Japan,
and Western Europe, especially Germany, is discussed. (MCW)

JAPAN'S SUNSHINE PROJECT: LONG-TERM ENERGY SOLUTIONS SOUGHT.

Technology Forecasts, May 1974, p.12-15.

Sunshine Project is designed to research
and develop technologies for pollution-free
solar energy, subterranean heat, substitute
natural gas, and hydrogen energy.

1974

OIL INDUSTRY PLUNGES INTO ALTERNATE ENERGY SEARCH. Snyder, R. E. World Oil: 178: No. 3, 61-62: 64: 66 (15 Feb 1974).

The Arab oil embargo has advanced time schedules for developing alternate energy sources in the United States to supplement rapidly diminishing and increasingly valuable crude oil and natural gas. Oil companies will be participating in the tar sand development in the Athabasca reserves in Canada. Geothermal development has only reached a practical level in the Geysers area of California. Synthetic fuel development will be pursued with RING converted from hydrocarbon liquids. No significant breakthrough has appeared for solar energy. Other eternal fuel sources include power generation from hydroelectric plants, tides, and wind. Other alternate fuel possibilities under consideration are hydrogen, more efficient electric power from fuel cells, direct heat or synthetic fuels from garbage or animal wastes. Additional mining of coal, or coal liquefaction, or gasification are processes to be perfected. Approximately 40 nuclear power plants are in operation and 37 more are under construction. Oil shale tracts in Colorado, Utah, and Wyoming are to be tapped. Tar sands reserves in the U. S. are located in California, Kentucky, Missouri, Oklahoma, Texas, and eight other states. (MCW)

FISSION ENERGY AND OTHER SOURCES OF ENERGY.

Alfven, H. Bull. At. Sci.: 30: No. 1, 4-8(Jan 1974).
The energy problem was discussed at the Pugwash conference at Oxford in 1972. Recommendations of an international institute for the study of the scientific, technological, political, and economic aspects of energy problems in the whole world were presented. The major recommendation was directed toward increased research on how to make fission energy acceptable. An effort should be made to develop alternative energy sources that satisfy ecological demands. An analysis should be made to determine the real need for additional energy. (MCW)

WIND, WASTE, OCEAN STUDIED FOR ENERGY.
Aviation Wk. & Space Tech., Jan. 14, 1974, p. 57.

Indirect solar sources—wind energy, bioconversion, and ocean thermal differences—are being studied.

PERSPECTIVES IN U. S. ENERGY RESOURCE DEVELOPMENT. Plumlee, R. H. Environ. Aff.: No. 1, 1-46(1974).
An inventory of U. S. energy resources is presented together with approximate timetables and product costs for implementation of the technologies necessary for clean utilization of these resources. These energy components include fossil fuels and their conversion to clean synthetic fuels, nuclear fuel supplies, geothermal energy, wind power, thermonuclear fusion, and the ultimate resource, solar energy. The cost of solar energy is treated in considerable detail for several prospective applications and basic energy conservation strategies are outlined. (131 references) (auth)

Title: Fission Energy and Other Sources of Energy
Author: Alfven, H.
PUBLICATION DESCRIPTION: Bulletin of the Atomic Scientists, Science and Public Affairs, 30(1), 4-8

PUBLICATION DATE: 1974, January
ABSTRACT: In order to produce more energy, the development of fission reactor technology is proceeding worldwide at a rapid pace. Part of the reason for this emphasis may be associated military support, either direct or indirect. The possible dangers of the large scale use of breeder reactors, with the huge production of plutonium, are pointed out. Intensive research efforts should be made to develop other sources of energy, such as fusion, geothermal, and solar. (JNC)

COST-BENEFIT ANALYSIS OF ADVANCED POWER GENERATION METHODS.

S. Baron.
Energy Sources, v.1, no.2, 1974, p.201-21.

19 April 1974

Volume 184, No. 4134

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BREAKING THE ENERGY CRISIS.

R.A. Huse.
IEEE Spectrum, v.11, no.6, June 1974, p.40-47.

Options cover primary energy resource recovery, fuel conditioning, conversion, improved transmission, and storage.

DESIGNING FOR THE ENERGY CRISIS.

1. THE VANISHING BTU. Larry L. Boulden.
Machine Design, Jan.24,1974, p.86-95.

This first in a series of articles shows how to look at our diminishing energy reserves and surveys the prospects for new sources of energy. Future articles: Feb.21 - Designing for the energy miser; April 4 - Processes that save power; May 2 - Efficiency by decree; and June 13 - Brownout-proofing your product.

ALTERNATE FUELS FOR TRANSPORTATION.

J.W. Hodgson.
Mechanical Engineering, v.96, no.7, July 1974, p.22-25.

Is ammonia a transportation fuel for the future? in light of current concerns involving air quality and predicted hydrocarbon fuel shortages, it may well be. Studies and data generated by the University of Tennessee's ammonia-fueled urban vehicle conclude that ammonia is attractive as a spark-ignition engine fuel because of its potential availability, adaptability to existing engine designs, cost, emissions, safety, and easy storage.

TK
2896
.A6

Angrist, Stanley W.
Direct energy conversion [by] Stanley W. Angrist. 2d ed. Boston, Allyn and Bacon [1974]
ix, 488 p. illus. 24 cm.

Comparative Evaluation of Solar, Fission, Fusion, and Fossil Energy Resources. Part 5: Conclusions and Recommendations. J. R. Williams.

Georgia Inst. of Tech., Atlanta. Schools of Mechanical and Nuclear Engineering. 1974, 9p NASA-CR-138183 N74-22604/4WE. 1PC\$4.00/MF\$1.45

Air pollution resulting from the use of fossil fuels is discussed. Phenomena relating to the emission of CO₂ such as the greenhouse effect and multiplier effect are explored. Particulate release is also discussed. The following recommendations are made for the elimination of fossil fuel combustion products in the United States: development of nuclear breeder reactors, use of solar energy systems, exploration of energy alternatives such as geothermal and fusion, and the substitution of coal for gas and oil use.

SUPERCONDUCTIVITY: LARGE-SCALE APPLICATIONS.

R.A. Hein.

Science, v.185, no.4147, July 19, 1974, p.211-222.

This article is an overview of areas involving large-scale applications of superconductivity for which the 1970's are a decade of critical decision. Applications to superconducting solenoids, high-energy physics, electric power transmission, rotating electrical machinery, energy storage and transfer, and superconducting magnets for superfast trains.

CENTER FOR ENERGY STUDIES. This report covers the past accomplishments and present capabilities of the Kansas State University College of Engineering in the power and energy related research. This report contains abstracts of technical articles, reports, theses and dissertations written by the faculty, staff, and students. The abstracts are classified into five sections: general and systems analysis, solar and wind energies, magnetohydrodynamics, nuclear energy, environmental effects and energy resources from wastes, and fuel production. Each section is subdivided into four subsections: Journal Articles, Presented Papers, Reports, and Theses and Dissertations. The order within each subsection is arranged chronologically.

For. L.T. Kan State Univ, Inst Syst Des Optimization. Rep n 50 Jul 1973. 24 p

COM-74-50365/SGA. Not available NTIS. National Bureau of Standards, Washington, D.C. MEASUREMENTS AND STANDARDS FOR HIGH TEMPERATURE MATERIALS IN ENERGY CONVERSION AND CLEAN FUEL PRODUCTION.

Final rept., J. B. Wachman, Jr., and S. J. Schneider. Aug 73, 5p. Pub. in Stand. News, v1 n6 p16-23 Aug 73.

Descripton: Coal, Energy, Electric power generation, Coal gasification, Gas turbines, Magnetohydrodynamic generators.

The serious energy situation in the United States requires more efficient generation of electric power and large production of clean fuel from coal. Both require high temperatures and highly reactive chemical conditions. The severe environments existing in high temperature gas turbines, MHD power generators, and coal gasifiers are briefly summarized. Data and test methods needed for process optimization, engineering design of hardware, and reliability assurance are analyzed. Early results are presented on slag characterization and on reaction of slag components with refractories. A procedure to insure required lifetime under service stress is described. The implications of the present work for practical test methods for mechanical lifetime assurance, corrosion resistance, electrical conductivity measurements, viscosity measurements, and wear are assessed.

N73-33005# California Univ., Livermore. Lawrence Livermore Lab. DEVELOPMENT OF MATERIALS FOR ENERGY RELATED APPLICATIONS

J. S. Kene 10 Apr. 1973 16 p refs Presented at 2d Cairo Solid State Conf. Cairo, 21-26 Apr. 1973 Sponsored by AEC (UCRL-74697; Conf-730416-2) Avail: NTIS HC \$3.00

The application of materials science and technology to develop new energy sources and to make current energy systems more efficient is discussed. The energy sources discussed include solar energy, thermonuclear energy, and fossil fuel energy. Energy conversion techniques discussed include thermal cycles, solar photovoltaic, thermal decomposition of water, and hydrogen-air fuel cells. The methods for energy transmission that are outlined are hydrogen pipelines and superconducting or cryogenic electrical transmission lines. Transportation optimization and efficiency are dealt with in the light of those components yielding the largest benefit for the overall system. NSA

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N74-15908 Rensselaer Polytechnic Inst., Troy, N.Y.
LONG RANGE TRENDS IN THE CHARACTER OF ELECTRIC POWER SYSTEMS Ph.D. Thesis

Charles A. Falcone 1973 388 p

Avail: Univ. Microfilms Order No. 73-27204

Long range trends in the development of electric power systems in the United States are discussed, emphasizing the Midwestern region. The historical growth of energy consumption in the United States is examined, along with present status and near-term prospects. Demographic and societal trends are discussed, and energy and electric power consumption are projected to year 2100, based on a scenario of future American society. The fuel resources of the United States are examined, as well as current and developmental energy conversion technology. A forecast of fuel use is developed. A history of energy systems is epitomized, with particular attention to electric power systems. Alternative energy systems are compared, and an examination of a hydrogen-electric system is included.

Dissert. Abstr.

(WASH-1281-6) CONVERSION TECHNIQUES. Sub-panel Report VI Used in Preparing the AEC Chairman's Report to the President. English, R. E. (USAEC, Washington, D. C.). 13 Nov 1973. 355p. Dep. NTIS \$20.75.

Improved energy conversion techniques for the reliable generation of electric power and for energy conservation are of great importance, and the goals of this R and D program are to (1) increase the efficiency of use of indigenous energy supplies (coal and uranium as well as new, alternate energy sources), (2) to reduce the environmental impact of this power production, and (3) to reduce the capital cost for construction of new power plants. For the purpose of reaching these goals, the following eight objectives were established: (1) coal gasification: to develop processes for the production and use of clean low-BTU gas from coal in central power stations; (2) gas turbines: to increase the overall efficiency and reliability of power generation by developing high-temperature gas-turbine systems; (3) MHD: to increase the overall efficiency and reliability of power generation by developing MHD power systems; (4) potassium topping cycle: to increase the overall efficiency and reliability of power generation by developing potassium-vapor topping systems; (5) fuel cells: to develop efficient and economical fuel cells for power generation; (6) use of waste heat and fuel: to develop power systems for economical use of heat and fuel presently wasted; (7) advanced concepts: to evaluate, to investigate, and ultimately to develop advanced concepts for energy conversion; and (8) enabling technology: to evolve the basic constituent technologies that enable the substantial improvement of various power systems or that make feasible entirely new concepts for power generation. An implicit constituent of these objectives is to minimize the environmental impact of power generation. These eight objectives represent a significant narrowing of the range of options considered. Under the pressure of severe budgetary constraints, the R and D originally proposed on low-temperature cycles was deferred and converted instead to a study under advanced concepts. Further, the use of waste heat and fuel was confined to the use of solid waste for power generation. (auth)

CN-129,601, Nos. 624 & 625, Audiotape (1973)
MEN AND MOLECULES. SIDE I: PROTEIN: THE NEXT BIG PRODUCTION? Steven Tannenbaum. (Radio Series 624).
SIDE II: CLEAN ENERGY: A ONE-WAY DREAM. J.R. Eaton. (Radio Series 625). (1973). (Audiotape).

American Chemical Society
American Chemical Society
American Chemical Society

SIDE I:
Proteins
Audiotapes - ACS
Human engineering & physiology - Food & Water

SIDE II:
Energy
Power Sources
Audiotapes - Energy
Audiotapes - ACS

Radio Series 624
Radio Series 625

L99,252 L-3-15-74

N74-16819# Army Construction Engineering Research Lab., Champaign, Ill.

ADVANCED ELECTRICAL POWER GENERATION AND DISTRIBUTION CONCEPTS FOR MILITARY FACILITIES
Jun. 1973. 134 p refs

(DA Proj: 4AO-62112-A-891)
(AD-765476; CERL-PR-E-13) Avail: NTIS CSCL 10/2
The report describes probable technical advancement of electrical power generation systems in the 1980-1990 time period for application in fixed or semi-fixed military facilities in the power range of 250 kw to 50,000 kw. Subjects covered include commercial power reliability, uninterruptible power system, conventional steam, diesel, gas turbine (open and closed cycle) generators and distribution systems for currently available equipment. Advanced power systems include nuclear reactors, batteries and fuel cells, magnetohydrodynamic systems, fusion systems, solar power systems and direct conversion systems of the thermoelectric and thermionic type. (Modified author abstract) GRA

THE SUPERCONDUCTORS ARE COMING.

J. C. Bittence.

Machine Design, v.45, July 26, 1973, p.76-81.

Superconductivity is being applied in a number of fields, including power generation and transmission. After a few more refinements--and within the next decade--the superconductor will become an important part of our daily lives.

ENERGY TECHNOLOGY: STATUS AND NEEDS. Society is faced with the problem of meeting energy needs in environmentally or socially acceptable ways using the remaining fossil fuels unable to decrease that nuclear fusion can ever be an acceptable energy source, and having little understanding of solar, geothermal, wind and other alternative sources. The support for development of new technologies, and the degree of public awareness of the options, are inadequate and problems are political, rather than technological. Total energy sources, and the potential for development, are evaluated. 17 refs.

Abrahamson, Dean Unit of Minn. Minneapolis. Ambio v 11 n 6 1973 p 186-193.

SPECIAL SECTION

24 PROSPECTING FOR ENERGY

Space developments fostered much of the advanced technology now in the limelight as prospective means for freeing the U.S. from its virtually complete dependence on oil, but driving that technology to the stage of commercial applications will take decades even if the country makes the necessary investment of several tens of billions of dollars. This special section, against a background of near-future energy prospects, presents the leading contenders as new sources of power towards the end of the century.

Astronautics & Aeronautics, v.11, no.8, Aug.1973.

A74-11219 # Gas generators - A perspective. W. H. Cutler (Lockheed Missiles and Space Co., Inc., Sunnyvale, Calif.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Conference, 9th, Las Vegas, Nev., Nov. 5-7, 1973, AIAA Paper 73-1168. 7 p. Members, \$1.50; nonmembers, \$2.00.*

The gas generator is usually thought of as a light weight, high power, short duration energy source, used mainly in aircraft and missiles. This premise is re-examined by viewing gas generators in the perspective of other energy sources with similar or overlapping characteristics and applications, to see where gas generators have a performance edge and where gaps exist which are opportunities for new gas generator applications. The alternative energy sources, which in addition to gas generators include gas turbines, reciprocating engines, compressed gas containers and hydraulic accumulators, flywheels, batteries, fuel cells, and solar photovoltaic cells, are first described in terms of their energy conversion process and the form in which their output energy is delivered. They are then compared on the basis of stored energy density and applicable power levels. Next, the factors involved in matching an energy source to its operating environment are enumerated. Finally, a number of new applications for gas generators are suggested which introduce new requirements in both technical and marketing areas.

(Author)

ENERGY OPTIONS. Bueche, A. M. (General Electric Research and Development Center, Schenectady, NY). J. Electrochem. Soc.: 120: No. 10, 295C-299C (Oct. 1973). Technical options available for use in solution of the energy crisis are reviewed. Discussions are included on sources and uses of energy with emphasis on electric power. Discussions are also included on fusion, magnetohydrodynamics, superconducting generators, potassium topping cycles, geothermal power, and storage and delivery of energy. (JRD)

NUCLEAR AND OTHER ENERGY. Seaborg, G. T. (Lawrence Radiation Lab., Berkeley, CA); Bloom, J. L.; Nelson, E. L. *Ann. N. Y. Acad. Sci.*: 216: 79-86 (18 May 1973).

Fossil fuels now supply over 95% of the U. S. commercial energy, and, even with a maximum effort to develop alternatives, the bulk of our cumulative requirements between now and the end of the century will have to be met from oil, gas, and coal resources. Nuclear, geothermal, and most other alternative forms of energy are restricted to a few specific uses, such as the generation of electricity. Consequently, fossil fuels cannot be replaced in many uses even after practical technologies to produce energy from other sources have been developed. There has been a serious effort to promote the use of nuclear fission for 25 years, and in 1971 it still accounted for less than one percent of the total U. S. energy supply. The National Environmental Policy Act of 1969 was designed as a statement of policy, but it also outlined certain procedures for all agencies of the government to follow. Courts have held that specific NEPA procedures are enforceable through suits of interested citizens. These cases brought to court have delayed the construction of vital facilities, especially electric power plants, and may contribute to energy shortages and other economic disruptions. (MCW)

Environmental energy sources, their use and storage. D.E. Johnson (SicMotive Inc., Tempe, Ariz., USA). 4th Annual Frontiers of Power Technology Conference, Stillwater, Okla., USA, 10-11 Oct. 1973 (Stillwater, Okla., USA: Oklahoma State Univ. 1973), p.6/1-31 (no refs.)

N74-18417# Systems Research Labs., Inc., Dayton, Ohio. INVESTIGATION IN ENERGY TRANSFER AND ENERGY CONVERSION FOR ADVANCED POWER AND PROPULSION SYSTEMS Final Report, 16 Mar. 1970 - 16 Mar. 1973 C. Calvert and J. Watson Oct. 1973 120 p refs (Contract F33615-70-C-1515; AF Proj. 7116) (AD-771581; ARL-73-0122) Avail: NTIS CSCL 10/2

The report covers the work done in three areas of energy conversion and transfer involving fluid dynamic processes: electrofluiddynamic energy conversion, multicomponent flow research, and aerodynamic energy transfer research. The effort under item one was an exploration of direct energy conversion of fluid dynamic energy into electrical power using electrofluid-dynamic (EFD) processes. The objective here was to identify workable and practical processes and designs for superior, lightweight, reliable, electrical generators. Item two covers studies of methods by which heat energy from reactions of solid particles or droplets contained in a combustion or reaction chamber can be used to produce fluid dynamic energy. The principal objective of this work was to assess wall erosion, particle suspension, and related fluid dynamic processes and components germane to practical thrust augmentation ejectors. The objective was to identify appropriate design concepts applicable to future vertical or short-field take-off-and-landing aircraft. (Modified vertical abstract)

1972

ALTERNATIVES TO NUCLEAR ENERGY. Heronemus, W. E. (Univ. of Massachusetts, Amherst). Catal. Environ. Qual.; 2: No. 3, 21-2(1972).

The feasibility of using solar energy and wind power created by solar energy as a non-polluting alternative to nuclear energy for electric power production is discussed. (LCL)

ENERGY OPTIONS: CHALLENGE FOR THE FUTURE.

A. L. Hammond.

Science, v.177, Sept.8,1972, p.

POWER GENERATION OPTIONS FOR THE EIGHTIES AND NINETIES. Kent, M. F. Pub. Util. Fortn.; 90: No. 4, 17-23(17 Aug 1972).

An evaluation of power generation from sources such as fusion, solar energy, geothermal energy, magnetohydrodynamic reactions, fuel cells, breeder reactors, desulfurized coal, and hydrogen is presented. Generation options for the 1980-to-1990 period are discussed along with power needs in the U. S. during the period 1980 to 2000. (J.R.D.)

1972

N74-18598 Atomic Energy Commission. Washington, D.C.

ENERGY OPTIONS FOR THE FUTURE

Clarence E. Larson In Mitre Corp. Symp. on Energy. Resources, and the Environment. Vol. 3 14 Apr. 1972 p 1-20 (For availability see N74-18598 09-34)

New technologies in energy conversion and new energy resources are considered that range from electric cars, solar energy conversion, magnetohydrodynamic power, geothermal energy, and nuclear fusion processes. The dominant role of the liquid metal cooled breeder reactor for providing future energy is emphasized. G.G.

S-421

Energy: 2000 A.D. F.C.Old.

Power Eng. (USA), vol. 76, no. 8, p.24-9 (Aug. 1972).

The author reviews present trends in power requirements, discusses current and projected energy sources and power systems, and suggests possible future trends. Special reference is made to a hydrogen fuelled power system.

IEEE Transactions on Industry Applications May/June 1973
v. 1A-9, no.3, pp.257-261

AN APPRAISAL OF FUTURE UNITED STATES POWER SOURCES.
Robert V. Price, National Coal Assoc. (Presented at the Petroleum and Chemical Industry Technical Conference, Denver, Colo., Sept.20,1972).

National Coal Association

Conference of the Petroleum and

Chemical Industry

Sept.20,
1972

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L-8-9-73

1973

S. J. FREEDMAN, Towne School of Civil and Mechanical Engineering, National Center for Energy Management and Power, University of Pennsylvania, Philadelphia, Pa. 19104.

Technical alternatives for energy management: *Energy Conversion* 13, 57-65 (1973).

Summary—The current energy management situation is presented in terms of the aspects limiting present practice. The conversion technologies available and being developed for the production of energy forms suitable for consumption from basic resources are summarized as technical alternatives. Options for continuing present trends in benefits of energy utilization include: development of processes to use new energy sources (U-238, Th-232, deuterium, gasified coal, geothermal and solar), more efficient power generation from present fuels (topping cycles, MHD and higher temperature gas turbines), and more efficient utilization of energy and power in the consumption process. All of these alternatives require substantial investment in capital resources, engineering of products and systems with long term performance in mind and more comprehensive planning of the entire energy utilization process.

Key words: Energy management energy conversion systems energy sources energy utilization

ENERGY: CRISIS AND CHALLENGE. Friedlander, G. D. IEEE (Inst. Elec. Electron. Eng.), Spectrum; 10: No. 5, 18-27(May 1973).

Availability, production technologies, and economics of fuels for energy generation are discussed. Data pertaining to the crises for now, 1985, 1990, and the year 2000 are outlined. Energy requirements are presently furnished by oil, 43%; natural gas, 33%; coal, 20%; and the remainder is furnished by nuclear and hydroelectric power and solar and geothermal energy. The blame for the fuel shortages and their certain, adverse impact on the economy can be placed at several doors: government, regulatory agencies, suppliers, and the general public. Coal remains in fairly good supply, and it seems that production and use of coal will have to be increased, although it is responsible for pollution of the atmosphere in many areas and restoration of the landscape from strip-mining is a problem. (JCW)

AMERICA'S ENERGY POTENTIAL: A SUMMARY AND EXPLANATION PREPARED BY CONGRESSMAN MORRIS K. UDALL, CHAIRMAN, SUBCOMMITTEE ON THE ENVIRONMENT FOR USE OF THE COMMITTEE ON INTERIOR AND INSULAR AFFAIRS OF THE U.S. HOUSE OF REPRESENTATIVES, NINETY-THIRD CONGRESS, FIRST SESSION, OCTOBER 1973. Washington, DC: Joint Committee on Atomic Energy (1973). 22p. GPO.

The survey reports the confirmation of the existence of two energy crises: the first results from an inability to extract known resources at a sufficient rate, already made evident by the gasoline and heat oil shortages. The longer-term crisis involves the ultimate exhaustion of fossil fuel resources and can be expected to occur around the end of the century. The status and outlook and what options are available to alleviate the developing crises are examined for oil and gas; coal; nuclear energy; solar energy; indirect solar applications of photosynthesis, wind energy; ocean thermal gradients, and conversion of waste materials; and geothermal energy. (MCW)

1973

1970's DEVELOPMENT OF 21ST CENTURY MOBILE—DISPERSED POWER. A mobile and dispersed power system is necessary for an advanced technological-industrial human society. Today's is based on petroleum and discharges waste products and heat. It is growing exponentially. Energy resource commitment has already intersected "ultimate" low-cost petroleum supplies in the U.S. and will do so for the world before 2000 A.D.; this portends major changes and cost increases. The complete change will require 23+ years because of the magnitude, fragmentation, structural gaps, complexity and variety of the mobile-dispersed power system. Consequently, substantial, sustained, interacting and coordinated planning, research and advanced development must be started now and completed during the 1970s. A "system dynamics" model of the resource-fuel-engine-use complex, and a "mixed-economy" Energy and Ecology Cybernetics Corporation should be integral parts of the effective management of the unprecedented development of society's 21st Century mobile-dispersed power system. 137 refs.

Elmings, Lamont Eaton Corp. SAE Paper n 730709 for Meet Aug 20-23 1973 27 p.

N73-33005# California Univ., Livermore. Lawrence Livermore Lab. DEVELOPMENT OF MATERIALS FOR ENERGY RELATED APPLICATIONS

J. S. Kane 10 Apr 1973 16 p refs Presented at 2d Cairo Solid State Conf., Cairo, 21-26 Apr. 1973 Sponsored by AEC (UCRL-74697; Conf-730416-2) Avail: NTIS HC \$3.00

The application of materials science and technology to develop new energy sources and to make current energy systems more efficient is discussed. The energy sources discussed include solar energy, thermonuclear energy, and fossil fuel energy. Energy conversion techniques discussed include thermal cycles, solar photovoltaic, thermal decomposition of water, and hydrogen-air fuel cells. The methods for energy transmission that are outlined are hydrogen pipelines and superconducting or cryogenic electrical transmission lines. Transportation optimization and efficiency are dealt with in the light of those components yielding the largest benefit for the overall system. NSA

N74-20619# Bureau of Mines, Bartlesville, Okla. Energy Research Center. ENERGY PROGRAM, 1972

Bill Linville and John D. Spencer 1973 115 p refs (BM-IC-8612) Avail: NTIS HC \$8.75

Major areas of research by the Bureau of Mines in 1972 for the development of new and improved efficient methods of conservation and utilization for petroleum and natural gas, oil shale, and coal are described. The major objective of the energy research program was to develop the technology for the wise development and use of the nation's energy resources as clean fuels at a reasonable and competitive cost. Emphasis was placed on studies of methods of stimulating production from oil and gas reservoirs. Studies of the fracturing systems of reservoir rocks and oil recovery by water or gas flooding are included. Author

N74-14097# Sydney Univ. (Australia). Dept. of Mechanical Engineering.
ALTERNATIVE ENERGY SOURCES: A RESEARCH CHALLENGE
 D. W. George 1973 21 p refs. Presented at Symp. on the Energy Crisis: Implications for Secondary Ind., Sydney, 23 May 1973
 (Conf-730560-1) Avail: AEC Depository Libraries HC \$3.25
 Methods of obtaining energy such as controlled thermonuclear fusion, direct solar conversion, or deep geothermal resources of energy are considered alternative energy sources in a global sense. In Australia, nuclear fission and natural gas are considered alternative or unconventional energy sources. One significant area of alternative energy source discussed is the energy currently dissipated to the environment in a nonproductive manner through the limitations of conventional conversion technology and which in overall terms often exceeds that actually used by a factor of two or three. Research into improved methods of conversion includes areas such as MHD power generation and fuel cells. It also includes the concept of total industrial energy. Other alternative energy sources discussed include the natural sources of primary energy, namely, solar energy, tidal energy, wind, and geothermal energy. NSA

LAST ROADBLOCKS TO NEW ENERGY CONVERSION PROJECTS. Latlin, C. P. Jr. Weld. J. (N.Y.): 52: No. 12, 800-803 (Dec 1973).
 Aspects of engineering and construction capabilities as related to improving energy production are reviewed. It is noted that a potential roadblock to new energy conversion projects is the improper allocation of engineering and construction manpower and supporting equipment. Current conditions of equipment materials availability are reviewed along with the status of engineering and skilled labor manpower pools. Methods for proper direction of manpower and proper use of materials and equipment are suggested. (JRD)

OIL DRUM TECHNOLOGY.

J. McCaull.
 Environment, v.15, no.7, Sept.1973, p.13-15.

Ways to use inexpensive technology, without massive social and environmental disruption, to meet energy needs are under study at the Brace Res. Inst. of McGill Univ., Montreal, Canada.

WORLD ENERGY STRATEGIES: FACTS, ISSUES, AND OPTIONS. Lovins, A. R. London; Earth Resources Research Ltd. (1973). 81p.

After a review of the condition and prospects of man's very large and unevenly distributed energy conversion, the outlook for both conventional and unconventional fossil fuels is surveyed. Possible rates and side effects of production; institutional problems, and the general trend towards fuels of increasing technical simplicity are stressed. Coal emerges in a critical role as the main bridge to sustainable energy economies. Nuclear fission is then analyzed in detail. It is argued that fission technology is so complex and demanding that it should be abandoned. Adequate alternatives are known. The status, prospects, and possible problems of other energy technologies (nuclear fusion, geothermal power, tidal power, hydroelectricity, indirect and direct solar collection, etc.) are then assessed and promising avenues identified: likewise energy conversion, storage, and distribution technologies. Decentralized methods, and the special needs of non-industrial countries seeking appropriate development paths, are specially noted. Technologies that rely on energy income rather than on energy capital are adequate to meet all reasonable future needs of mankind. The foregoing considerations are combined with an assessment of certain ethical issues related to distribution, competition, climatic constraints, and future risks (e.g., in strategic-material safeguards, LNG transport, Arctic oil-spills, and radiation biology) to yield general conclusions. (auth)

Solar Energy Proof of Concept Experiments.
 Mitre Corp., McLean, Va. Dec 73. 106p MTR-6337, NSF.
 RA/N-73-111C
 PB-231 143/9WE PC\$4.50/MF\$1.45

Critical experiments are described which are intended to prove the technical feasibility and socio-economic desirability of specific applications or techniques for the widespread use of solar energy. These experiments fall within the following areas: Heating and Cooling of Buildings, Process Heat, Thermal-Electric, Photovoltaic, Ocean Thermal, Wind Energy, Organic Materials and Common Applications. The specific concept which the experiment is intended to prove and a rationale for the experiment are given. Each experiment is described in terms of the system to be constructed, its pacing and high-risk items, the intended users, desired interfaces with other systems and users, and estimated costs for the experiment. Each experiment is described and costs estimated for two levels of funding: a moderate-risk 'minimum program' and a low-risk 'accelerated program'. (Modified author abstract)

Solar Energy Research Program Alternatives, Proposed Research Tasks, Costs and Schedules for the National Science Foundation Five-Year Solar Energy Research Program, MITRE Corp., McLean, Va. Dec 73, 149p MTR-6516, NSF-RA/N-73-111B PB-231 141/3WE PCS4.75/MF\$1.45

The MITRE Corporation is formulating a five-year solar energy research program as a recommendation to the National Science Foundation Applied Research Directorate Office of Systems Integration and Analysis. This document provides two alternative research plans, including task schedules and costs, for each of eight program elements: Heating and Cooling of Buildings, Process Heat, Thermal-Electric Energy Conversion, Photovoltaic Energy Conversion, Ocean Thermal Systems, Wind Energy Systems, Utilization of Organic Materials, and Common Applications. The two alternatives are: (a) a set of research tasks considered to be the minimum necessary to bring about the widespread utilization of solar energy and (b) an accelerated plan to achieve more rapid utilization, with a higher degree of confidence and reduced technical risk. (Author)

Dissemination and Utilization of Solar Energy Research Results, Report to the Office of Systems Integration and Analysis Directorate of Applied Research, National Science Foundation.

Richard S. Greeley.
MITRE Corp., McLean, Va. Dec 73, 69p MTR-6544, NSD-RA/N-73-111D PB-231 144/7WE PCS3.75/MF\$1.45

Thirty recommendations have been made for establishing groups within or reporting to the NSF Solar Energy Program Office and initiating activities for the dissemination and utilization of solar energy research results. The primary recommendations include establishing an Advisory Commission and an information office reporting to the Program Director and constructing visitor centers on the sites of each Proof of Concept Experiment. Training courses and public education would be conducted at each center following successful operation of the POCE system. (Modified author abstract)

(BNL-18376) SURVEY OF LARGE-SCALE APPLICATIONS OF SUPERCONDUCTIVITY. Informal Report. Powell, J. R. (Brookhaven National Lab., Upton, N.Y. USA). 1973. 167p. (CONF-730970-). Dep. NTIS \$10.50.

From Advanced Study Institute on Large Scale Applications of Superconductivity and Magnetism; Entreves, Italy (5 Sep 1973). A survey is made of potential future large-scale uses of superconductivity, including fusion, MHD, magnetic energy storage, power transmission, high-speed ground transport, and magnetic separation. The superconducting technological requirements for each application are examined with regard to present and projected capabilities. The requirements of the nonsuperconducting system components in each application are also examined, together with an investigation of how advances in superconducting technology can ease demands on the nonsuperconducting components. Economic and social factors relating to each application are also discussed. An assessment of the likelihood of success for each application is made. (18 tables, 27 figures, 89 references) (auth)

TITLE: Fusion and Other Long-Range Strategies
AUTHOR: Rose, D.J.
CORPORATE AUTHOR: Massachusetts Institute of Technology
ADDRESS: Cambridge, MA
PUBLICATION DESCRIPTION: Consulting Engineer, 40(3), 164-170

PUBLICATION DATE: 1973, March
ABSTRACT: Long-range possibilities for energy sources include controlled nuclear fusion, new technologies for coal, geothermal energy, burning organic refuse, and growing organic material to burn. Nuclear fusion is discussed first, including the four possible methods of achieving fusion: torus, magnetic mirror, theta-pinch, and laser pellet. The author feels that the toroidal method is likely to succeed and that the theta-pinch method might succeed. Fission and fusion are compared. If fusion ever replaces fission, it will do so only very gradually in the 21st century. The chief disadvantages of coal are the hazards of underground mining, the land devastation of surface mining, and effluents, such as SO₂. New coal technology, particularly gasification, is described as a possibility for reducing SO₂ emissions. Other possible energy sources are briefly reviewed. (NPG)

ALTERNATIVES FOR ENERGY DEVELOPMENT.

Technology Forecasts, v.5, no.7, July 1973, p.10-13.

Second in a series of articles on analysis of possible energy developments made at the Symposium on New Sources of Energy, Hosted by Univ. Southern California.

ENERGY SOURCES AND CONVERSION TECHNIQUES.

R. Roberts.

Amer. Scientist, v.61, no.1, Jan./Feb.1973.

NATURAL POWER FOR THE THIRD WORLD.

D. Spurgeon.

New Scientist, Dec.6,1973, p.694-697.

Geothermal energy, solar power, and wind power could make a significant contribution, but the developed countries will have to help exploit these systems.

UNCONVENTIONAL SOURCES OF ENERGY FOR MILLIONS.

Rao, V. A. (University Grants Commission, New Delhi). Sci. Cult. (Calcutta); 39: No. 4, 157-163(Apr 1973).

A study of the present rate of development of the conventional sources of energy in India in recent years indicated that coal, oil, and radioactive sources of energy will be exhausted by the end of the present century. In order to meet the increasing demand of energy for agricultural development and in order to solve the socio-economic and environmental-pollution problems, the necessity of the development of unconventional sources of energy — solar, wind, geothermal, and tidal — is stressed. (auth)

LONG-RANGE APPROACHES FOR RESOLVING THE ENERGY CRISIS.

Weinberg, A. M. (Oak Ridge National Lab., TN). Mech. Eng.; 95: No. 6, 14-18(Jun 1973).

Long-range possibilities for generation of prime energy (other than the nuclear breeder) are basically only three: solar, fusion, and geothermal. Predictions in favor of one or the other of these possibilities tend to take on the character of prophecy, principally because the prophet knows he will probably be dead by the time the returns are in. Fermi, for example, discussed the fast breeder, not expected before the mid-eighties, in 1943. The prophets may be right, but a prudent overall energy policy must be based on the two firm alternatives — clean energy from coal and from nuclear sources, particularly from the breeder. (auth)

(SLA-73-163) PERSPECTIVES IN U. S. ENERGY RESOURCE DEVELOPMENT.

Plumlee, R. H. (Sandia Lab., Albuquerque, N. Mex.) Mar 1973. 113p. Dep. NTIS \$7.75.

The extent, availability, cost, and development schedules of existing and potential domestic U. S. energy resources are surveyed in the context of projected U. S. energy demand. These energy components include fossil fuels and their conversion to clean synthetic fuels, nuclear fuel supplies, geothermal energy, wind power, thermonuclear fusion, and solar energy. The cost of solar energy utilization in several prospective applications is treated in considerable detail. (8 tables, 7 figures, 99 references) (auth)

1972

1973

Measurements and Standards for High Temperature Materials in Energy Conversion and Clean Fuel Production.
J. B. Wachtman, Jr., and S. J. Schneider.
National Bureau of Standards, Washington, D.C. Aug 73.
8p Pub. in Stand. News, v1 n8 p16-23 Aug 73.
COM-74-50385/5WE Not available NTIS.

The serious energy situation in the United States requires more efficient generation of electric power and large production of clean fuel from coal. Both require high temperatures and highly reactive chemical conditions. The severe environments existing in high temperature gas turbines, MHD power generators, and coal gasifiers are briefly summarized. Data and test methods needed for process optimization, engineering design of hardware, and reliability assurance are analyzed. Early results are presented on slag characterization and on reaction of slag components with refractories. A procedure to insure required lifetime under service stress is described. The implications of the present work for practical test methods for mechanical lifetime assurance, corrosion resistance, electrical conductivity measurements, viscosity measurements, and wear are assessed.

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1972
IEEE Power Engineering Society Conference on Research for the Electric Power Industry, Washington, D.C., 1972.
Conference on research for the electric power industry. [New York, Institute of Electrical and Electronic Engineers, 1973]
455 p. illus. 28 cm.

FIFTH SESSION - ENERGY CONVERSION III - EMBRYONIC
p.197-224.

(Solar energy, fuel cell, satellite with energy transmission by microwave, etc.)

N74-18604 Office of Science and Technology. Washington, D.C.
ENERGY OPTIONS
Richard E. Balzhiser In Mitre Corp. Symp. on Energy Resources and the Environment. Vol. 3 14 Apr. 1972 p 109-129 (For availability see N74-18598 09-34)

Technological options to solving the energy problem constitute development of the liquid metal gas breeder reactor to produce nuclear energy; coal gasification to produce a synthetic natural gas; and SO2 removal technology from stack gases to permit high sulfur coal burning. Fusion, solar, and geothermal energies are prime candidates for supplementing above primary needs.
Author

N73-13884* Air Force Aero Propulsion Lab., Wright-Patterson AFB, Ohio.
POWER AND ENERGY FOR POSTERITY c23
Robert F. Barthelemy and Robert F. Cooper In NASA. Marshall Space Flight Center Space for Mankind's Benefit 1972 p 355-359 (For availability see N73-13829 04-30)
CSCL 10B

The use of sophisticated space energy generation and storage systems to benefit the general public was examined. The utilization of these systems for pollution-free generation of energy to satisfy mankind's future electrical, thermal, and propulsion needs was of primary concern. Ground, air, and space transportation; commercial, peaking, and emergency electrical power; and metropolitan and unit thermal energy requirements were considered. Each type of energy system was first analyzed in terms of its utility in satisfying the requirement, and then its potential in reducing the air, noise, thermal, water, and nuclear pollution from future electrical and thermal systems was determined.
Author

CN-140,353

TITLE: Energy: Uses, Sources, Issues
AUTHOR: Austin, A.L.; Rubin, B.; Werth, G.C.
CORPORATE AUTHOR: Lawrence Livermore Laboratory, University of California
ADDRESS: Livermore, CA 94550
PUBLICATION DESCRIPTION: Report No. UCRL-51221, 125 p.

PUBLICATION DATE: 1972, May
ABSTRACT: The problems and issues involved in providing our nation with abundant supplies of low cost energy are extremely complex, particularly when we give full attention to minimizing the environmental impacts. An immense amount of information has been generated on the subject. This report condenses the data and sets them out in a format designed to emphasize the major points characteristic of the respective problems and issues. (Auth, Preface)
AVAILABILITY: NTIS

ENERGY SOURCES FOR THE FUTURE.

E. Cook.

The Futurist, Aug.1972, v.6, no.4, p.142-150.

World consumption of energy is rising rapidly, but the reserves of oil and gas are limited and may be virtually exhausted in a few decades. To replace them, man may turn to nuclear power and a much older energy source - coal.

177

ENERGY: PROBLEMS, PROSPECTS, AND PRIORITIES.
R.M. Drake, Jr., Combustion Engineering.

AIAA Paper no.72-253

AIAA 7th Thermophysics Conference, San Antonio,
Texas. Apr.10-12,1972.

Energy Digest, v.11, no.7, Apr.30,1972.

Solar economy

Hydrogen economy

Hydrogen car by 1977

Italian chemical H₂ process

Fusion could produce H₂

Fission high energy radiation: H₂ source.

Garbage to methane

ALTERNATIVES: R AND D FOR NEW ENERGY

SOURCES. Econ. Priorities Rep.; 3: No. 2, 23-25(May 1972).

As a result of the advent of nuclear power, utilities have come to growing reliance on federal government for long-range R and D. Of 0.23% of gross revenues that industry does spend on R and D, most is used for improving present systems and not on developing new, minimally polluting ones. Reviewed are economic, environmental, and political aspects of the nuclear breeder reactor (which gets lion's share of attention), proposed fusion reactor, solar energy (totally ignored by utilities and government), geothermal steam, tidal energy, wind generation, direct conversion (MHD and fuel cells), recycling waste heat, coal gasification, and establishing of national power grid. (NSIC)

ENERGY FOR MILLENNIUM THREE. E. Cook, Texas A & M.
Technology Review, Dec.1972, p.16-23.

Beyond 2100, mankind's energy needs must be met by a combination of coal, nuclear power, and solar energy - beyond 2300, by technologies that are not yet known to be possible, much less economical.

POWER GENERATION - SOME TASKS AND GOALS.

J.L. Everett, III.

IEEE Trans. Aerospace & Electronic Systems,
v.AES-8, no.4, July 1972, p.498-503.

Generating capacity additions planned for the 1970's and beyond include a high percentage of nuclear power plants. The light water reactor is the dominant type of commercial nuclear reactor being installed during the 1970's. Advancement to more efficient designs is expected around 1980. Prospects for breeder reactor and fusion dictate a major effort.

A COMEBACK FOR REDDY KILOWATT?

G.D. Friedlander, Senior Staff Writer.

IEEE Spectrum, Apr.1972, p.44-50.

Depletion of fossil fuel, and the time lag in building nuclear plants, is spurring the search for new devices and resources.

TITLE: Alternative Sources of Energy

AUTHOR: CREISMITH, R.S.
CORPORATE AUTHOR: Oak Ridge National Laboratory,

ORNL-NSP Environmental Program

ADDRESS: P.O. Box 1, Oak Ridge, TN 37830

PUBLICATION DESCRIPTION: Paper presented at the 26th Annual Conference of the Middle East Institute, Plenary Panel I, Pressures of Energy Demands on Resources, published in World Energy Demands and the Middle East, Part 1, 69-74

PUBLICATION DATE: 1972, September 29

ABSTRACT: Sources of energy other than gas and oil are reviewed, including: synthetic gas and oil from coal; tar sands; oil shale; nuclear fission, including present nuclear reactors and breeder reactors; nuclear fusion; solar energy; geothermal energy; and solid wastes, which can be burned or processed to give methane. The paper concludes with a brief discussion of the demand for energy, the need for energy conservation, and the need for a reexamination of government policies promoting the use of energy. (196)

TWENTY-TWENTY VISION: A VIEW OF THE FUTURE. Faust, George R. (Gilbert Associates, Inc., Washington, D. C.). Pub. Util. Forum; 90; No. 4, 24-32(17 Aug 1972). The state of present technology related to gas and electric utilities is examined and the chances of using advanced technology in dealing with the problems associated with utility depreciation accrual rates are evaluated. Discussions are included on gas industry, coal gasification research, atomic energy, magnetohydrodynamics, fuel cells, and underground transmission lines. (J.R.D.)

NEW ENERGY TECHNOLOGY. Balzhiser, R. E. (Office of Science and Tech., Washington, DC). pp 145-156 of Space Technology Transfer to Community and Industry. Tripp, R. H. (ed.). Tarzana, CA: American Astronautical Society (1972). From Proceedings of the AAS eighteenth annual meeting and the tenth Goddard memorial symposium; Washington, DC (13 Mar 1972). See CONF-720343-.

The technological options which appear to be feasible for the future development of energy resources are discussed. Technological objectives must include making available additional energy reserves and utilizing them more efficiently and with minimal environmental degradation. The President's energy message to Congress is discussed. The Federal effort on the Liquid Metal Fast Breeder Reactor is singled out for priority treatment. Other areas designated by the President for increased attention includes coal gasification and more efficient use of oil and gas resources. Another program designated by the President for immediate attention is SO₂ control technology. This program has as its aim the elimination of SO₂ in the atmosphere from the burning of high sulfur fuels in large central power stations. Other methods for energy generation are discussed, e.g., MHD, fuel cells, nuclear stimulation of natural gas, geothermal energy, and solar energy. (RCN)

A73-34111 Applications of superconductivity. 8. 8. Goodman (British Oxygen Co., Ltd., London, England). In: Trends in Physics: General Conference, 2nd, Wiesbaden, West Germany, October 3-6, 1972. Lectures. (A73-34109/17-34) Petit-Lancry, Switzerland, European Physical Society, 1973, p. 67-94. 79 refs.

While, in the past, numerous applications of superconductivity have been suggested, those which now appear capable of competing effectively with other technologies are grouped into the use of Type 2 areas. By far the most important at present is in the use of Type 2 superconductors to produce large dc (or slowly time dependent) magnetic fields for use in research, in novel types of electrical machinery and possibly in magnetically levitated trains. In this area, the advantage of using superconductors appears to be greatest for the large scale projects. Secondly, superconductivity is of interest in two types of application which do not specifically require high fields, linear accelerators and power cables. Finally, the Josephson effect is leading to the development of a rich harvest of electronic devices with unique properties of sensitivity and accuracy. (Author)

AN ENGINEER LOOKS AT THE ENERGY DILEMMA.

R.W. Graham. NASA Lewis.

Mechanical Engineering, v.93, no.2, Feb.1972, p.40-46.

The demand for energy is growing at such an accelerated rate that the attendant problems of pollution and fossil fuel supply depletion point to an urgent need for revision of engineering priorities before making critical decisions for the future. Development of nuclear power, more pollution-free sources of energy, and new concepts of transportation are challenges.

UNITED STATES ENERGY. A Summary Review. Washington, DC: Department of the Interior (1972). 50p. GPO.

Today to supply adequate energy in the USA involves the development of the technology for a wise use of the energy resources available at a reasonable and competitive cost. National objectives include national security, conservation, environmental protection, consumer protection, and international trade. Energy requirements at the present time are discussed. Information on energy resources, their supply and demand, is summarized for electric power, coal, natural gas, petroleum, solar energy, controlled thermonuclear fusion, tidal energy, fuel cells, and geothermal energy. (52 references) (JCW)

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THE SEARCH FOR TOMORROW'S POWER.
K.F. Weaver.
National Geographic, v.142, no.5, Nov.1972,
p.650-681.

TRADITIONAL ENERGY RESOURCES: Present Status and
Future Development. Richard Bailey.

Futures June 1972 pp. 103-114.

ENERGY TECHNOLOGY TO THE YEAR 2000. PART III:
ENERGY SOURCES AND USES.
Technology Review, Jan.1972, p.9-48.

ROCKET POWER TO LIGHT THE CITIES.
Skyline, v.30, no.4, 1972, p.22-27.

The quest for fusion power. L.M. Lidsky.
Creating power plants; the costs of controlling
technology. W.W. Lowe.
System energy and future transportation. R.A. Rice.
An agenda for energy. H.C. Hottel & J.B. Howard.

By generating steam instead of thrust, modified
rocket engines may help solve the impending
energy crisis.

74N72717 72/02/23 67 PAGES UNCLASSIFIED DOCUMENT
TOTAL IMPACTS OF ALTERNATIVE ENERGY SYSTEMS
A/MORRISON, W. E.
FEDERAL POWER COMMISSION, WASHINGTON, D.C. (OFFICE OF ECONOMICS.)
AVAIL. NTIS
PRESENTED AT ANN. MEETING OF THE AM. INST. OF MINING, MET. AND
PETROL. ENGR., SAN FRANCISCO, 23 FEB. 1972
/*ENERGY POLICY/*ENERGY REQUIREMENTS/*ENERGY SOURCES/*ENERGY
TECHNOLOGY/ DEMAND (ECONOMICS)/ GEOTHERMAL RESOURCES/ NUCLEAR ENERGY

74N72162 72/00/00 58 PAGES UNCLASSIFIED DOCUMENT
THE FUTURE DEVELOPMENT OF ENERGY SUPPLY SYSTEMS
A/LINDEN, F. R. AVAIL. NTIS
INSTITUTE OF GAS TECHNOLOGY, CHICAGO, ILL.
PRESENTED AT THE FUEL CCNF. IN COMMUNICATION OF THE GOLDEN
JUBILEE OF THE FUEL SOC. OF JAPAN, TOKYO, 31 OCT. - 2 NOV. 1972
/*ENERGY REQUIREMENTS/*ENERGY TECHNOLOGY/ ENERGY CONSUMPTION/
FOSSIL FUELS/ SOLAR ENERGY

N74-18587 California Univ., Livermore. Lawrence Livermore Lab.
ENERGY IN GENERAL
 Glenn C. Werth. In: *Mitre Corp. Symp. on Energy Resources and the Environment*, Vol. 1, 12 Apr. 1972, p. 105-136 refs (For availability see N74-18582 09-34)

Technical aspects of providing energy and utilizing resources for world-wide demand are considered. Projected energy flow patterns recognize growth demands fossil fuel reserves that require definite economic and technological adjustments. Better utilization of the coal and oil shale resources can be obtained by secondary and tertiary recovery methods such as water flood and fire flood, or nuclear explosions, a move to gasifying coal underground also seems to be feasible. Nuclear breeder reactor development is technically proven but economic feasibility must be considered. Solar energy source developments require storage facilities in principle; hydrogen seems to be the best product to be used as a fuel and possible for transportation markets. Emphasis is placed on making all these fuel resources available at acceptable prices for the world's community. G.G.

N74-117964 InterTechnology Corp., Warrenton, Va.
THE U.S. ENERGY PROBLEM. VOLUME 2: APPENDICES.
 PART B Final Report, Dec. 1970 - Nov. 1971
 G. C. Szego. Nov. 1971. 688 p. refs 2 Vol.

(Grant NSF C-845)
 (PB-207619; NSF-RANN-71-1-3) Avail: NTIS HC\$12.50 CSCL 108
 An analysis of the energy requirements and energy sources for the United States is presented. The subjects discussed are: (1) off-peak storage, (2) state of electrochemical research and development of fuel cells, (3) alternate energy conversion cycles, (4) effects of failures of cryogenic superconductivity on electrical transmission lines, (5) transportation requirements, (6) environmental factors, (7) future investment capital for public utilities, (8) supply and demand analysis for energy related minerals, (9) economic model for primary industries, (10) technology of alternate fuels, (11) a petroleum refinery model, and (12) the current state of thermionic energy conversion technology. Author

N71-76399
 Title: Report to the Secretary of the Interior of the Advisory Committee on Energy
 AUTHOR: McKetta, J.J., Jr. (Chairman)
 CORPORATE AUTHOR: U.S. Dept. of the Interior
 ADDRESS: Washington, DC 20240
 PUBLICATION DESCRIPTION: PB 201 071: 38 p.
 PUBLICATION DATE: 1971, June 30
 ABSTRACT: This report provides information on the problems that the nation faces with respect to energy. Position, problems, outlook, and recommendations are presented for energy in general, elemental and new technology energy sources, petroleum liquid fuels, natural gas, coal, water, nuclear energy, synthetic oils, and synthetic gas. (NPG)

1972
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 v.26
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Technology utilization ideas for the 70's and beyond. Edited by F. W. Forbes [and] P. Dergarabedian. Tarzana, Calif., AAS Publications Office [1971]
 xiv, 315 p. illus. 25 cm. (AAS science and technology series, v. 26)
 An American Astronautical Society publication. Proceedings of a special AAS/AIAA technical event, held October 30, 1970 at Winrock, Arkansas at the invitation of Governor Winthrop Rockefeller. P.1-

POLLUTION CONTROL USING ADVANCED ENERGY GENERATION SYSTEMS

Robert R. Barthelemy
 Air Force Aero Propulsion Laboratory
 Wright-Patterson AFB, Ohio 45433

Abstract

One of the most critical problems facing the world today is the alarming increase in environmental pollution. The three most important forms of pollution are thermal heating of our water supplies, chemical pollution of the atmosphere and, to a lesser degree, the introduction of waste (nuclear and chemical) into the soil. This adverse situation arises primarily because it is impossible to convert all of the latent energy of chemical and nuclear fuels into desirable directed energy, either kinetic or electrical. Short of moving our conversion and manufacturing systems into space (which may eventually become necessary), our only technological recourse is to minimize the contaminating effects of our major conversion processes.

Recent Air Force developments in the fields of high temperature energy sources and advanced energy conversion processes could be utilized to significantly improve the processes used for generating electrical power. Although electrical power generation is not the sole contributor to environmental pollution, it plays a major part. The use of high temperature nuclear reactor thermal systems coupled to high efficiency generation systems could reduce the thermal pollution of generation plants several fold and completely eliminate particulate pollution of the atmosphere, with little or no contamination of the earth with nuclear by-products.

Two technical areas being pursued by the Air Force are applicable. Gaseous core nuclear reactors are being studied in basic and exploratory development for future space rocket uses. Such a system, however, could produce a power generation system working fluid at 4000°K. Exploratory development of magnetohydrodynamic (MHD) generators for airborne and space system power has shown high efficiency operation if high temperature gases are used. Coupled to 4000°K gases, these generators could convert 60-70% of the gas thermal energy into electrical power. This efficiency is 50% higher than the most modern advanced steam turbine plant and over 100% more efficient than conventional nuclear power plants. The amount of thermal pollution of cooling streams should be reduced by a factor of 3 to 5. In addition, the decreased cost of electrical power through improved efficiency operation would result in a savings of about one billion dollars/year at the present consumption rate.

N71-29852# Atomic Energy Commission, Washington, D.C.

ENERGY SOURCES OF TOMORROW

W. E. Johnson *In its Proc. of the 11th AEC Air Cleaning Conf.*
Vol. 2 Dec. 1970 p 459-466

Avail: NTIS HC\$6.00/MF\$0.95

The energy required in the USA in the future to keep the environment habitable for an expanding population and the relation between our environment and energy are discussed. It is concluded that 6 times the present electric energy capacity will be needed by the year 2000 to clean the environment and to maintain a reasonable standard of living for the additional population. Methods must be found for producing, distributing, and both cleanly and economically using fossil fuels. The more efficient breeder reactors must be developed for the economic use of nuclear fuels in commercial power plants. Finally, a nationally coordinated system for planning, developing, constructing, financing, and operating power plants is needed to achieve both the future electric energy needs and the environmental compatibility requirements. NSA

N89-15054 Oklahoma State Univ. Stillwater

A SYSTEM FOR THE ECONOMIC ANALYSIS OF BALANCED ENERGY CONVERSION AND STORAGE SYSTEMS

Arthur Bruckner, II (Ph.D. Thesis) 1967 231 p

Avail: Univ. Microfilms: HC \$10.60/Microfilm \$3.00 Order No. 68-8369

A simulation system is developed to examine the economic feasibility of combined energy conversion and storage systems on the basis of annual energy demand. Annual demand is the basis for the optimization trade-off function in order to realize the full savings potential from generation plant investment as well as short term advantages in fuel economies. The objectives are the determination of storage equipment requirements so that the necessary or high potential research directions are identified in the early stages of a research and development project. Some case study indications are: no major annual effects on fuel costs, equipment cost advantages between storage procedures, probable cost advantages from over-capacity generation facilities in conventional energy source systems. Extended storage technology research in balanced nuclear plant generation and storage systems is a recommendation.

Dissert. Abstr

B. FOSSIL FUELS

Comparative Evaluation of Solar, Fission, Fusion, and Fossil Energy Resources. Part 4: Energy from Fossil Fuels.

J. R. Williams.

Georgia Inst. of Tech., Atlanta. Schools of Mechanical and Nuclear Engineering. 1974. 51p NASA-CR-138188

N74-22603/6WE PCS5.75/MF\$1.45

The conversion of fossil-fired power plants now burning oil or gas to burn coal is discussed along with the relaxation of air quality standards and the development of coal gasification processes to insure a continued supply of gas from coal. The location of oil fields, refining areas, natural gas fields, and pipelines in the U.S. is shown. The technologies of modern fossil-fired boilers and gas turbines are defined along with the new technologies of fluid-bed boilers and MHD generators.

N74-18633/ Transportation Systems Center, Cambridge.

Mess.

ENERGY STATISTICS: A SUPPLEMENT TO THE SUMMARY OF NATIONAL TRANSPORTATION STATISTICS Final

Report, Jun. - Jul. 1973

Gill V. Hicks Sep. 1973 94 p. refs

(PB-225331/8CA; DOT-TSC-OST-73-34)

HC \$3.75 CSEL 05C

NTIS

The report is a compendium of selected time series data

describing the transportation, promotion, processing, and

consumption of energy. The report is divided into three main

sections. The first contains such items as the revenues and

expenses of oil pipeline companies, number and capacities of

U.S. tank ships, and the total crude oil transported in the U.S.

by methods of transportation. The second section reveals the

growth over time of the U.S. oil and natural gas reserves, refinery

capacity, and yields. Trends in demand for fuel and power are

displayed in the third section. Throughout this part, the transportation

sector is emphasized. Included are the gasoline and oil

costs of automobiles of different sizes, the consumption of the

petroleum by type of product, the energy intensiveness of the

air carriers, the electrical energy consumed by the local transit

industry, and other important statistics describing the supply and

demand for energy

GRA

WESTERN STATES PLAN HUGE FOSSIL FUEL DEVELOPMENT. Snyder, R. E. World Oil; 178: No. 4, 39-42(Mar 1974).

A summary was given at the Tri-State Fossil Fuels Energy Conference in Denver, Col., January 31 and February 1, 1974 of the plan for fossil fuel development in the Western United States. Warnings were issued by oil companies in 1964 to 1970 of the perils of the dependency on Arab oil. Iran's finance minister said,

"And please remember that you in the West have enough coal for 400 years. But our oil will last for only 30 years or so. Do you want our grandchildren to beg you for their shortage needs?" The conventional methods of coal development were discussed and the Lawrence Livermore Lab technique for underground coal gasification was presented. Three methods for mining and processing oil shale that were discussed were TOSCO II process involving room and pillar mining, ore crushing, and surface retorting; Occidental in situ process; and nuclear in situ recovery. Natural gas recovery in impermeable rocks and nuclear stimulation for gas were discussed. (MCW)

Economic Analyses of Fossil Fuel Markets Using Parametric Models.

Robert J. Kalter.

Department of the Interior, Washington, D.C. Office of Policy Analysis. Dec 73. 64p DOI-PEC-73-1

PB-229 950/1WE PCS3.75/MF\$1.45

The report describes parametric models of the fossil fuel (coal, oil, and gas) markets, at two levels. First, models for individual fuels are based on historical data and assumed interactions of supply, demand, and price. Supply and demand elasticities and other significant variables are parameters which can be specified by the user. Secondly, the individual fuel models are linked through a constraint on price differential. The model is exercised for likely values of the parameters, and the implications of alternative parameter values and alternative government policies are discussed. (Author)

(WASH-1281-2) MINING: COAL AND OIL SHALE. Subpanel Report II Used in Preparing the AEC Chairman's Report to the President. Schmidt, W. B. (USAEC, Washington, D. C.). 27 Oct 1973. 242p. Dep. NTIS \$15.25.

Coal and oil shale together constitute 90% of our fossil fuel energy reserves. If these resources are to fulfill the expanding role demanded of them, better mining technology must be developed. This is the research area dealt with by this subpanel. Three subpanels are presented: "surface coal mining", "underground mining", and "oil shale mining". Research for the three subpanels is recommended on the principal problem areas of mining systems, environmental protection, social and economic effects, and resource recovery. The overall objective of the recommended coal and shale research mining program is the rapid development and demonstration of technology to satisfactorily mine these important energy sources. This technology must meet the required demands at acceptable costs with minimal environmental impacts. Also, this mining must be done in a manner that assures miners' health and safety and makes wise use of these resources. In the near term, the coal surface-mining segment of the program will concentrate on improving extraction/reclamation technology to allow acceptable rates anticipated. In and Western coals at the unprecedented mining of both Eastern the near term, the underground coal mining portion of the program will concentrate on the development of improved underground mining methods to provide a viable complement to our surface coal mining capabilities. The oil shale mining program will concentrate on mining of thick Western shale deposits in a manner that complements emerging government/industry efforts to develop these reserves in an environmentally acceptable manner. (auth)

Plowshare Technology Assessment. Energy Development

Trends.

John C. Bellamy, and Michael C. Penz.

Western Interstate Nuclear Board, Lakewood, Colo. Jan 73.

29p NSF-RA-G-73-013

PB-231 039/9WE PCS4.50/MF\$1.45

An analysis of probable future needs for energy in relation to potential sources of energy and environmental concerns is used to postulate how those needs might best be served. It is thereby postulated that nuclear heating plants can well be developed to serve most of our needs for heat and electrical energy in stationary locations, and that fossil fuels can thereby well be conserved largely for propelling vehicles. It is thereby also seen that nuclear explosives are likely to be needed to extend the use of natural gas for stationary heating needs during the transitional period. (Author)

CHALLENGES IN PRODUCTION OF FOSSIL FUELS.

Hottel, H. C. (Massachusetts Inst. of Tech., Cambridge). Chem. Eng. Progr.; 69, No. 6, 35-39 (Jun 1973).

The near-term growth pattern of U. S. energy consumption will not depart significantly from the pattern of the past. This growth is finally catching up with our capacity to supply energy in practically acceptable forms. There is no expectation that nuclear power will contribute more than one-fourth of the total energy needed by 2000 A.D. (counting nuclear-source electrical energy as the equivalent of the thermal energy needed to produce it, at an efficiency of one-third). The half-lives of our factories, machines, and industrial processes and of our mores and customs are great enough that, much as improvement in energy use is to be encouraged, major change in GNP and services produced per unit of energy consumed cannot be expected to occur fast enough to have a major impact in the near term. Our supplies of coal are enormous compared to other fossil resources and supplies of oil shale are less impressive. The suggestion that the energy needed in near term (1985 to 2000) can come from nonfossil fuels only confuses the issue in that it is not feasible yet. Six alternatives are: Import large quantities of crude oil and/or oil products and large quantities of liquefied natural gas; encourage more vigorous search for gas and oil, as by changing the federal position on gas price control and on federal land lease; increase the research effort on improved recovery of oil and gas from the ground; increase the efficiency of use of energy; learn how to burn coal cleanly; and convert coal, shale oil, bitumens to clean gas or clean oil. (MCW)

CM-129, 738, Side I & II (1973)
THE ENERGY CRISIS. (Incls. SIDE I: THE GAS SUPPLIES OF THE UNITED STATES-PRESENT AND FUTURE; Gordon K. Zaretski. SIDE II: LOW SULPHUR COAL SUPPLIES FOR ENVIRONMENTAL PURPOSES. Thomas W. Emter. THE SUPPLY OF OIL FOR FUTURE U.S. NEEDS AND THE SUBSEQUENT EFFECTS ON THE ENVIRONMENT. Gene P. Morrell, David R. Oliver & J. L. L. Ried. THE DEMAND FOR SULPHUR OXIDE CONTROL METHODS IN ELECTRIC POWER AND GENERATION. Robert M. Jameson). (Presented at the ACS Symp. on Environ. Pollution Control, Part I, Held at the 164th ACS Nat'l Meeting, N.Y., N.Y., Aug. 28-31, 1972). (Series title: ACS Audio Research Reports). (1973). Audiotape.

American Chemical Society
 Symposium on Environmental Pollution Aug. 28-31, 1972
 Control; Part I - The Energy Situation 193,264
 & its Environmental Impact

DISTANCE IS SOVIET ENERGY WORRY. Energy Int.

The USSR contains abundant resources of primary energy, but the problem deals with the distance of these resources from the industrialized areas. The Soviet Union has about half the world's natural gas reserves, rich oil and hydropower resources, and practically inexhaustible coal deposits. Two solutions to the problem are being studied—construction of a special coal-freight super-railway and generation of electricity at the mine mouth and then transmit it to the Western republics. Then the development of more efficient pipelines and power transmission lines is necessary. The Soviet cooperation in energy production with Western countries and pacts signed with other countries are discussed. (MCW)

TITLE: Oil Shale, Coal, and the Energy Crisis
AUTHOR: Seichman, B.P.
CORPORATE AUTHOR: Superior Oil Co.
ADDRESS: Houston, TX
PUBLICATION DESCRIPTION: Chemical Engineering Progress, 69(5), 92-95
PUBLICATION DATE: 1971, May
ABSTRACT: Oil shale and coal are the only domestic reserves in large supply. A system is proposed to mine the oil shale and process it to recover low-sulfur crude oil, naphcolite, and aluminum hydrate. By 1981, a plant could be on stream producing 40,000 barrel/day oil, 15,000 ton/day naphcolite, and 3,000 ton/day aluminum trihydrate. The naphcolite could be used as a scrubber for SO2 in coal burning plants. (JNC)
AVAILABILITY: Complete manuscript (No. 2272) of 27 pages available from AIChE Publications Dept., 145 E. 27th St., New York, NY 10017 (\$6.00 U.S. prepaid; foreign, add \$2.50 prepaid)

FOSSIL FUEL — POWER & POLLUTION.
 G. Alex Mills and Harry Perry.
 ChemTech, Jan. 1973, p.53-63.

Where we are and just where we're going in the future.

(ORO-4507-1) PLANNING CRITERIA RELATIVE TO A NATIONAL RDT AND E PROGRAM DIRECTED TO THE ENHANCED RECOVERY OF CRUDE OIL AND NATURAL GAS. Final Report. (Gulf Universities Research Consortium, Galveston, Tex. (USA)). 30 Nov 1973. Contract AT(4C-1)-4507. 63p. (GURC-130). Dep. NTIS \$5.45.

Enhanced recovery methods, problems, prospects, and status of methods under development and/or testing are summarized from data, forecasts, estimates, and opinions of 36 oil and gas production research, forecasting, and operating engineers. The industry investigation was conducted to determine the extent to which possible price increases would result in increased production and reserves of domestic crude oil and natural gas through the application of enhanced (non-conventional) recovery methods; the probable benefits to be derived from a federally supported, or partially supported, research and development program concerning the enhanced recovery of crude oil and natural gas as a possible component of a national energy program; and the definition of the general character, content, time, and cost of such a program. The conference conclusions and recommendations are enumerated. (MCW)

N74-12677* Auburn Univ., Ala.

ENERGY RESOURCES

In *its TERRASTAR: Terrest. Appl. of Solar Technol. and Res.* Sep. 1973 34 p refs (For availability see N74-12674 03-34)

CSCL 20M

A statistical analysis of the availability of fossil fuels for energy and non-energy production is presented. The cumulative requirements for petroleum, natural gas, and coal are discussed. Alternate forms of energy are described and the advantages and limitations are analyzed. Emphasis is placed on solar energy availability and methods for conversion. The Federal energy research and development funding for energy sources is tabulated. Author

N74-15259 Geological Survey, Washington, D.C.

OIL AND GAS

T. H. McCulloh In *its US Mineral Resources* 1973 p 477-496 refs (For availability see N74-15214 06-18)

The oil and gas resources of the United States are examined. Organic carbon, hydrocarbons, and producible hydrocarbon accumulations are discussed from the standpoint of distribution and accessibility. All estimates of petroleum and natural gas resources depend upon prior exploration results and are considered unreliable. Changing economic incentives, technologic advances, enlarged prospecting areas, and creative thinking all increase exploration effectiveness. Data are presented to show variations in produced and proven reserves of oil for the U.S. and the world.

U. S. Energy Outlook: Oil and Gas Availability. 1973. National Petroleum Council, 1625 K. St., N.W., Suite 601, Washington, D. C. 20006. 768 pp., paper. \$25.00.

This is one of the task group reports of the National Petroleum Council's Committee on U. S. Energy Outlook. These task group reports have been prepared to include methodology, data, illustration, and computer-program descriptions for the particular area studied by the task group. This report is divided into two major parts: summary of oil and gas availability studies and findings of the oil- and gas-supply task groups. Part 1 is subdivided into sections on domestic oil and gas availability, foreign oil and gas availability, and oil and gas logistics and imports. Part 2 consists of the following sections: NPC methods of analysis of oil and gas supplies; oil operations; gas operations; economics—oil and gas; parametric studies; and foreign oil and gas availability.

N74-18313# Esso Research and Engineering Co., Linden, N.J. Government Research Lab.

POTENTIAL POLLUTANTS IN FOSSIL FUELS

E. M. Magee, H. J. Hall, and G. M. Varga, Jr. Jun. 1973 292 p refs

(Contract EPA-68-02-0629)

(PB-225039/7GA; GRU-2DJ-73; EPA-R2-73-249) Avail: NTIS HC \$6.50 CSCL 13B

This survey presents the composition of typical U.S. fossil fuels by source location, and the extent to which the selection of coals and crude oils by geographic source can be expected to affect their composition in trace elements. The first section deals with coals produced and consumed in the United States. A section on petroleum and shale oil includes domestic crudes and crudes from nations which export to this country. The number of elements for which statistical data on composition and geographical location exist is entirely different for crude oil and for coal. Good data and useful correlations with source locations are available for petroleum, for sulfur, nitrogen and nickel/vanadium, but not for other potential pollutants. A large body of data is available for trace elements in coal, and is examined herein. For both coal and petroleum, however, the level of trace elements present is relatively low so that methods of sample selection and sample handling, prior to analysis, can and do present major complications in the interpretation of results. GRA

The Naval Petroleum Reserves and Their Relevancy in the Decade 1975-1985. (Are the 'Other' Naval Reserves Necessary). John K. Teel. Army War Coll Carlisle Barracks Pa 15 Oct 73, 38p AD-779 995/OWE PCS5.00/MF\$1.45

In 1912 President Taft established two Naval Petroleum Reserves ...to reserve certain fuel oil deposits for the use of the American Navy'. A third was established by President Wilson in 1915, and a fourth was added by President Harding in 1923. Naval Oil Shale Reserves 1 and 2 were designated in 1916 and No. 3, in 1924. For the most part, these land set-asides are in a standby status (Reserves Nos. 1, 3 and 4), about exhausted (Reserve no. 2), or undeveloped (Naval Shale Oil Reserves Nos. 1, 2 and 3). The report examines the present domestic available-energy deficiency and concludes that petroleum is the only energy source that can be stretched sufficiently to cover the widening gap in supply and demand. Since crude oil imports must fill this gap, at least for the next decade, the economics and strategic aspects of this dependence are discussed. (Modified author abstract)

ARTIC OIL AND GAS.

Oil & Gas Jour., v.71, no.37, Sept.10,1973, p.71-154. 8 articles.

(TID-26528, pp 75-129) FOSSIL FUEL OPTION.

Chapter II. Perry, H. (National Economic Research Associates, Washington, DC). Dec 1973.

In report of the Cornell Workshops on the major issues of a national energy research and development program, September 14, 1973-October 17, 1973.

The nation will continue to be dependent upon fossil fuels for the next twenty to thirty years. Conservation will provide the time needed to bring the new, cleaner energy sources and technology into use. New environmental regulations will increase energy resource requirements until new processes are developed that are less energy intensive per unit of product. A summary of fossil fuel energy resources for proved, proved and probable; and proved, probable, and possible is given. New methods for increasing oil and gas reserves; deep and strip coal mining; utilization of coal by direct combustion, gasification, and liquefaction; oil shale development; and environmental considerations are discussed. Appendices to Chapter II include the rate at which strip mining capacity could be increased and strategy for coal research and development. A cost summary is included. (MCW)

ENERGY UNDER THE OCEANS. A Technology Assessment of Outer Continental Shelf Oil and Gas Operations. Kash, D. E.; White, I. L.; Bergey, K. H.; Chartock, M. A.; Devine, M. D.; Leonard, R. L.; Salomon, S. N.; Young, H. W. Norman, OK; University of Oklahoma Press (1973). 397p. \$20.00.

The technology assessment of the U. S. outer continental shelf oil and gas operations is an attempt to introduce all consequences well beyond the conventional considerations of economic costs and benefits or immediate implications for the perpetrator or user of technology. The assessment study attempts to inform the interested public and the decision-makers of the possible ranges of consequences of new actions. An examination was made of the development of outer continental shelf oil and gas resources and how policies are currently established. Topics are discussed such as the adequacy of present technologies, the quality of environment and environmental control, government management, and federal and state jurisdiction. Then recommendations are given regarding government policy and administration, industry management, and technologies that will contribute to optimal resource development. (MCW)

N74-15691# Bureau of Mines. Bartlesville, Okla. Energy Research Center.

SELECTED LIST OF BUREAU OF MINES PUBLICATIONS ON PETROLEUM AND NATURAL GAS, 1961-1970 V. Vern Hutchinson [1972] 165 p refs Supplement to BM-IC-8240

(BM-IC-8534; BM-IC-8240-Suppl) Avail: SOD HC \$1.75 This selected list contains 829 entries with citations to publications related to petroleum and natural gas, which were released during the 1961-1970 period. Some entries are multiple in nature, resulting in a total of 881 citations. The purpose of this bibliography is to provide a selective review of publications related to petroleum and natural gas during the 1961-1970 period. The publications are grouped under broad headings as shown in the contents section. Indexes, placed at the end of the list, identify publications by author with short title, detailed subject approaches, and report numbers. As the title indicates, the publications included have, for the most part, a direct and specific relationship to petroleum and natural gas. In some selections, however, the reports included are applicable to other energy fuels as well. Author

FUTURE OF THE FUELS MARKET.

Energy Digest, June 19,1972, p.122-125.

Economists say coal and gas prices will outpace inflation through 1985 while oil and uranium will rise more slowly.

1972

TK
173
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1972
IEEE Power Engineering Society Conference on
Research for the Electric Power Industry,
Washington, D.C., 1972.
Conference on research for the electric power
industry. [New York, Institute of Electrical
and Electronic Engineers, 1973]
455 p. illus. 28 cm.

FOURTH SESSION - ENERGY CONVERSION II - FOSSIL.
p.155-196.

EARTH'S DWINDLING STOCK OF FOSSIL FUELS.

L. Howles.
New Scientist and Science J., v.51, no.763,
Aug.1971, p.320-22.

1971

N74-10669# Committee on Interior and Insular Affairs (U. S.
Senate).

COMPACT TO CONSERVE OIL AND GAS
Washington GPO 1971 30 p. Hearing on S. J. Res. 72
before Comm. on Interior and Insular Affairs, 93d Congr., 1st
Sess., 17 Jun. 1971

Avail: Subcomm. on Minerals, and Fuels
A Congressional hearing concerning an extension of the
Interstate Compact to Conserve Oil and Gas was conducted.
The purpose of the compact is to prevent physical waste of
natural resources within the states which ratify the compact.
The states are expected to accomplish the legislation to prevent
the following: (1) operation of any oil well with an inefficient
gas-oil ratio, (2) drowning with water of any stratum capable of
producing oil or gas, or both oil and gas, in paying quantities,
(3) avoidable escape into the open air or the wasteful burning
of gas from a natural gas well, (4) the creation of unnecessary
fire hazards, (5) the drilling, equipping, locating, spacing, or
operating a well or wells so as to bring about physical waste of
oil or gas, and (6) the inefficient, excessive, or improper use of
reservoir energy in producing wells. Author

FOSSIL FUEL SUPPLIES AND FUTURE ENERGY NEEDS.

H.E. Risser.

Amer. Geophysical Union Trans., v.52, no.11,
1971, p.763-767.

73V20796 1971 ISS 00 TJD3.N27 333.82C973 LC-72-172997
U.S. ENERGY OUTLOOK AN INITIAL APPRAISAL, 1971-1985; AN INTERIM
REPORT. CHAIRMAN--JOHN G. MCLEAN.
NATIONAL PETROLEUM COUNCIL. COMMITTEE ON UNITED STATES ENERGY
OUTLOOK.

NATIONAL PETROLEUM COUNCIL. WASHINGTON, 2 v. ILLS. 28 cm.
VOL. 2. SUMMARIES OF TASK GROUP REPORTS; AND FULL TEXT OF THE
REPORTS BY OIL LOGISTICS, OIL AND GAS CAPITAL REQUIREMENTS, GAS DEMAND,
GAS TRANSPORTATION, AND TAR SANDS TASK GROUPS. FULL TEXT OF THE REPORTS
OF THE OTHER TASK GROUPS ARE ISSUED BY THE COMMITTEE IN 8 V. WITH
TITLE U.S. ENERGY OUTLOOK, AN INTERIM REPORT, AN INITIAL APPRAISAL.
LC POWER RESOURCES -- UNITED STATES.

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1974

CONTRIVERSY OVER PROPOSED U.S. REGULATION OF
SURFACE MINING OF COAL: PROS AND CONS.
The Congressional Digest, v.53, no.5, May 1974,
p.131-160.

The Foreword

Scope of Present U.S. Coal Production and Consumption
Basic Methods Used in the Surface Mining of Coal
How the States Regulate Surface Mining of Coal
Action to Date in the 93rd Congress

PRO and CON Discussion ==

*Should the Federal Government Assume a Direct Role
in the Regulation of Surface Mining of Coal in the States?*

JOINING NORTHEAST POWER PLANTS TO AP-
PALACHIAN COAL: WHAT CHANCE. Coal Age, 79: N. 1,
62-3(Jan 1974).

Appalachian coal is needed to relieve the energy shortages
in the northeast USA. Some utilities are converting from oil to
coal; and the effort controlling the allowable sulfur content in
the coal must be relaxed. Some restraints that hinder rapid
response to the need for coal include: not much coal is avail-
able since mines in operation are committed to long-term
contracts; lead time for new mines is from four to six years
and the development would have to be a sure act for investors
to participate; railroads and waterways are approaching full
handling capacity; shortages of labor are due to long term
training of miners and maintenance personnel, and the present
return on investments is minimal. (MCW)

The Limits to Kentucky Coal Output: A Short-Term Analysis.

Stuart A. Schweitzer.
Kentucky Univ., Lexington. Coll. of Engineering. Feb 74,
31p UKY-TR81-74-IMMR2
PB-230 775/9WE PC\$4.75/MF\$1.45

While the demand for Kentucky coal and market prices have
increased dramatically in recent months, the capacity of the
Kentucky coal industry to increase its output is seriously
limited in the near term. This report attempts to identify cur-
rent coal industry problems which may influence the level of
coal output in the next year or two and to estimate by how
much Kentucky coal output may be expected to rise during
that period. The analysis for this report is based upon conver-
sations with coal industry spokesmen as well as with represen-
tatives of state government and the coal-hauling railroads.

TITLE: Progress in Coal Research

AUTHOR: Kelley, J.H.
CORPORATE AUTHOR: West Virginia University
PUBLICATION DESCRIPTION: Mining Congress Journal,
60(2), 101-102

PUBLICATION DATE: 1974, February

ABSTRACT: Federal programs for coal utilization
research were begun about 10 years ago to
counter the possible decline in coal markets.
Currently, coal research and utilization
programs have been accelerated because of the
emphasis on environmental quality and energy
shortages. Trends in coal production include
decreasing size of mined coal; concern for
sulfur content leading to preparation plants
stressing sulfur removal rather than ash
removal; better designed, more compact and
efficient coal preparation and separation

Science, v.184, no.4134, Apr.19,1974.

Problems of Expanding Coal Production: J. Walsh

..... 336

High-Sulfur Coal for Generating Electricity: J. T. Dunham, C. Rampack,
T. A. Henric

..... 346

The Supply of Coal

The United States has vast reserves of coal, both in the well-explored regions east of the Mississippi River and in partially-explored portions of Wyoming and Montana. Whether these reserves can be developed in time to make a significant contribution to Project Independence depends upon the cost of mining and transporting the coal to final markets and on the growth in demand for coal. These factors, in turn, are influenced by political matters—principally environmental protection regulations against sulfur emissions from coal burned to generate electricity.

LOW-SULFUR COAL: THE FASTEST GUM-UP IN THE WEST. Holyoak, R. H. Elec. Light Power, E/G Ed.; 52; No. 1, 33-35 (Jan 1974).

Commonwealth Edison boilers were designed to use a high-rank, type-C bituminous coal from Illinois. The characteristics of the Illinois coal are given and compared to western coal, which is now being used. Illinois coal is not now acceptable in most of the system because of ordinances limiting sulfur and SO₂ discharges and lack of technology to reduce the sulfur content. Western coal is inferior to Illinois coal except in the area of sulfur content and, in some cases, ash content. Testing results are presented on Colstrip, Arch Mineral, and Decker coals and compared with the percent sulfur, Btu/lb heating value, percent reduction Btu, and percent moisture characteristics of the Illinois coal. Preparation, ash handling, water treatments, and combustion in cyclone-fired boilers are some of the problems discussed for western coal. The precipitators on the Commonwealth Edison system were upgraded to utilize the western coal. (MCW)

THE REKINDLING OF COAL.

Skyline, v.32, no.1, 1974, p.25-29.

In answer to the energy crunch, technology offers an alternative solution with a plentiful resource.

COAL AND THE PRESENT ENERGY SITUATION. Osborn, E. F. (Carnegie Institution of Washington, DC). Science, 183; No. 4124, 477-481 (8 Feb 1974).

Coal is an energy resource that is in great abundance. The first step is to move immediately to replace the oil and gas used in electric generating plants with coal and to require that coal be used in fossil-fuel electric plants planned or under construction in the next few years. The technology to remove sulfur and particulates from the stack gases is at hand, and therefore environmental regulations can be met. Mining and transporting the required increased tonnage of coal are problems that can be met with appropriate incentives to the coal and transportation industries. Oil and gas from coal should be in significant commercial production in about a decade. Underground, or in situ, gasification of coal looks promising. Recoverable methane occurs in coal beds in the United States in an amount approximately equal to the total reserves of natural gas—about 260 trillion cubic feet. This large reserve of natural gas should be exploited as quickly as possible. (30 references) (MCW)

CLEARING THE WAY FOR THE NEW AGE OF COAL.

E. Faltermayer.

Fortune, May 1974, p.215-219, 334, 336, 338.

In the rush for energy, the U.S. will be tearing coal from the ground as never before. Moonscapes and dustbowls must not be the result.

COAL AND THE PRESENT ENERGY SITUATION.

E.F. Osborn.

Science, v.183, no.4124, Feb.8, 1974, p.477-481.

Abundant coal reserves can be used to alleviate the oil and gas shortage.

1974

POWER FROM COAL. I. Coal Selection and Handling.
Power; 118: No. 2, SI-S24(Feb 1974).

The basics of selection and key facts about coal and the equipment and methodology of coal handling are discussed. It is indicated that it will take years to gain momentum in coal development. The first requisite for coal development is to know its availability, and then an analysis is essential. The characteristics of coal discussed include moisture, ash, volatile matter, fixed carbon, and sulfur content, ash-fusibility temperature, heating value, and all their related properties. Dust suppression and transportation of coal are discussed. In-transfer operation, bucket elevators, continuous-flow conveyor, and belt conveyors were described for unloading coal. (MCW)

POWER FROM COAL. II. Combustion and Ash-Handling Practice. Power; 118: No. 3, S25-S48(Mar 1974).

The theory of coal combustion is described. Fuel/air ratios, proper mixing, differences between fuel-bed and suspension firing, basic arrangements at the mill for coal sizing, fineness or quality of mill output, and volatile guidelines are discussed. Ash increases the cost of shipping and handling coal, and its content in coal determines the size and type of ash-handling system. System selection is closely related to ash content, how coal is burned, and amount and type of ash collected. Small plants use exhausters. (MCW)

POWER FROM COAL. III. Combustion Controls and Pollution Controls. Power; 118: No. 4, S49-S64(Apr 1974).

Economical and safe steam generation in industrial and utility plants demands precise and reliable control equipment. Boilers must have controls that will maintain steam pressure within ± 1 to 2% of the design point, fuel/air ratio within $\pm 5\%$ of excess-air requirements over the entire load range, and steam-drum water level within ± 1 in. of the desired height. Regulation of combustion, burner-management, and feedwater controls is required. Combustion and burner-management are discussed. Four equipment designs are discussed to curb stack dust emissions. Stack emissions from coal-fired boilers consist of particulates, oxides of nitrogen, and sulfur dioxide. Control of particulates and nitrogen oxides are discussed. The characteristics of the coal must first be known. (MCW)

1974

GREAT COAL RUSH OF THE 1970's. Environ. Sci. Technol.; 8: No. 3, 208-209(Mar 1974).

The American Petroleum Institute issued warnings on an impending fuel problem in 1954. Fossil fuels were still used at record rates. In 1973, the federal government requested some power plants to switch from oil to coal. The switch to coal-fired boilers is expensive and then the added expense of pollution control equipment for particulate matter, sulfur and nitrogen oxides produced from coal combustion puts hard-ship on the utilities. New plants are utilizing designs for dual-fuel boilers. Coal is basically still plentiful in the U. S. and new methods are being developed to make cleaner burning fuels and useful chemical by-products from coal. The use of coal would produce self-sufficiency of the U. S. for its energy needs. (MCW)

HIGHLIGHTS OF A BUSY YEAR FOR COAL. Coal Age; 79: No. 2, 70-3(Feb 1974).

In 1973, 590 million tons of coal were produced. In order to increase the 1974 production to 660 million tons, the following criteria must be attained: labor stability with an end to absenteeism and wildcat stoppages; effective enforcement of mine health and safety laws without harassment or unnecessary mine closures; continue surface mining with reasonable reclamation requirements; adequate rail hopper cars; exemption from price controls of all coal sales; variances in air pollution control regulations to allow burning of available high-sulfur coals; and adequate mine supplies, especially roof bolts, fuels, and explosives. Suitable sites have been selected for coal gasification plants. SNG from coal is expected to be competitive with gas brought by pipeline from Alaska, gas imported as a liquid in cryogenic tankers, and SNG produced from naphtha or other feedstocks. (MCW)

(UCRL-51520) **HYDROEXPLOSIVE MINING: A METHOD FOR DEVELOPING DEEP, THICK SEAMS OF COAL.** Archibald, P. B. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 8 Mar 1974. Contract W-7405-eng-48. 18p. Dep. NTIS \$4.00.

Hydroexplosive mining is suggested as one way to economically develop deep, thick seams of coal without adversely affecting the environment. It is also considered as an alternative to strip mining. Hydroexplosive techniques are examined and some preliminary experiments are described. (auth)

ENERGY REPORT/COAL R & D PROGRAM TO LEAD DRIVE FOR SELF SUFFICIENCY. J.G. Phillips.

Nat. Jour., v.6, no.28, July 13, 1974, p.1047-55.

A 10-year, \$20 billion research and development effort is being contemplated as part of the drive to make the United States self-sufficient in energy by 1980. A major share of that money will go to coal R & D with the aim of making coal available in such great quantities that it becomes a prime energy source well into the next century. Special planning groups are to submit their blueprint to President Nixon by Nov. 1 outlining how funds are to be distributed. The program can be likened to the effort to land a man on the moon, but says one task force director, it's much more difficult.

This is the last of three reports on the role of coal in the nation's energy future. The first report, in issue No. 26, dealt with the short-term outlook for coal supplies. The second report, in last week's issue No. 27, discussed the argument over whether future production should be concentrated in eastern or western mines.

THE FUTURE OF COAL IN FRANCE AND IN THE WORLD.

G. Delannoy.
Entropie, no.55, Jan./Feb.1974, p.20-24.

(In French)

The world-wide production of petroleum, while increasing rapidly, provides at the present time 40 % of energy requirements; coal production, increasing only slowly, provides 30 %. The coal-mining industry in Western Europe has slowed down sharply in recent years, but coal reserves throughout the world remain by far the largest and represent at this time 90 % of the world's energy reserves. For certain purposes, and particularly in the iron and steel industries, petroleum cannot take the place of coal; for others, everything depends on production costs. At present, atomic power does not enter into competition with coal except in the making of electricity. We can state here several outlets which could be opening up for coal: gasification, carbon fibres, carbojet, etc... CER-CHAR has carried out very thorough research on many of these projects. This article reminds us that the part played by coal will remain of first rate importance to the whole world, even though France has only a small supply.

ENERGY REPORT/COAL INDUSTRY PROBLEMS HAMPER PRODUCTION GOALS. J.G. Phillips.

Nat. Jour. Repts., 6/29/74, p.951-961.

The key to achieving energy self-sufficiency by 1980—President Nixon's Project Independence—is coal, the "great black hope" that comprises 93 per cent of the nation's energy reserves. Production must increase 10 per cent a year between now and 1980 and 20 per cent between 1980 and 1985 to reach the goals of Project Independence. Coal producers say they can't meet those goals unless steps are taken to alleviate problems that include shortages of capital, equipment, manpower and transportation and regulations affecting air quality, strip mining and employee safety.

CAN COAL BAIL US OUT? Elec. Light Power, E/G Ed.; 52: No. 3, 14-18(Feb 1974).

Coal must make a comeback, but the general practice in times past has been to use coal when other fuels were not available. Coal production did not increase in 1973. Coal output increase can only be achieved if wildcat strikes and absenteeism stops, mine health and safety harassment subsides, adequate transportation is furnished, price controls abolished, and air pollution laws changed so that sulfur content is disregarded. The coal industry must be assured of a long-term market and iron-clad contracts before new mining is developed. The coal industry needs necessary raw materials to operate at full capacity and this includes diesel fuel, roof bolts for safety, ammonium nitrate for explosives, and a continuing supply of machinery and replacement parts. (MCW)

KING COAL'S LAST CHANCE. Papamarcos, J.

Power Eng.; 78: No. 3, 39-45(Mar 1974).

Nuclear power growth projections, labor problems, cheap gas, health and safety regulations, and environmental protection laws caused the coal industry to lag behind in exploration and the opening of new mines in the last few years. Uncertainties still prevail even when nuclear power plants were delayed and shortages and prices surged ahead for oil and gas. Mining methods are discussed in relation to prevailing environment and health regulations. The trend in energy consumption is toward reverting back to coal, but mines cannot be opened overnight, miners cannot be trained overnight. The industry faces critical shortages of mining materials, such as roof bolts, diesel oil, ammonium nitrate, electric cable, and machinery and replacement parts. Forecasts hold that an investment of about \$30 billion is needed by 1985 for the coal industry to be reinstated. (MCW)

The UK coal industry - recent past and future

Richard Bailey

Against a background of rising prices and unsure supplies of oil, coal is rapidly regaining its former position as a key fuel in the UK. In this article, Mr Bailey traces the history of the industry from its decline in the 1960s to the substantial assistance given in the Coal Industry Act of 1973, and discusses the 1974 miners' wage settlement in relation to the future importance of coal for both the UK and the EEC.

TITLE: Surface Mining of Coal
CORPORATE AUTHOR: American Mining Congress, Mining Congress Journal
ADDRESS: 110 Ring Bldg., Washington, DC 20036
PUBLICATION DESCRIPTION: Mining Congress Journal, 60(2), 109-113, 121

PUBLICATION DATE: 1974, February
ABSTRACT: Projections of unprecedented coal production from surface mines may not be met if surface mining reclamation legislation is not modified. Bureau of Mines data show that there are demonstrated recoverable coal reserves amounting to 200 to 250 billion tons, of which 18 percent is stripable. This much coal that can be mined by present surface methods cannot be ignored. The article gives brief descriptions of Western United States surface mined coal development, gasification projects in Wyoming, and new mine plans for Indiana. Equipment developments for hauling, loading, and excavating coal in surface mines are described. A short summary of land reclamation programs is given. (DCN)

TITLE: Coal Preparation 1973
AUTHOR: Deurbrouck, A.W.
CORPORATE AUTHOR: U.S. Dept. of Interior, Bureau of Mines, Pittsburgh Energy Research Center
PUBLICATION DESCRIPTION: Mining Congress Journal, 60(2), 65-67

PUBLICATION DATE: 1974, February
ABSTRACT: The United States will increase its production of coal markedly as energy shortages become more acute. This will result in more coal being washed to reduce the sulfur and dangerous trace constituents content. This article describes a high capacity sedimentation unit for clarifying crushed coal influent feedstocks, a jig for washing coal fines, schemes for washing coal using combinations of water-only and heavy-medium cyclones, and a froth flotation washing method for producing steam coals. A brief description of two research studies conducted by the Bureau of Mines concerning coal preparation is included. The first study has shown the value of coal washing for removal of potentially hazardous trace elements from raw coal. The second study is a pyrite removal process after washing the coal. (DCN)

TITLE: Underground Mining of Coal
AUTHOR: Wallwork, G.W.
CORPORATE AUTHOR: American Electric Power Service Corp.

PUBLICATION DESCRIPTION: Mining Congress Journal, 60(2), 84-90, 95

PUBLICATION DATE: 1974, February
ABSTRACT: There has been an unwillingness of underground miners to commit additional or new capital in nonconforming reserves because of uncertainty with respect to environmental regulations. This reluctance is holding back major expansion in the industry and as most new deep mining operations require a minimum of 2 years to be brought into production, it is doubtful that production of deep mined coal can meet the immediate demands of the energy crisis. Other problems confronting the underground coal miners are equipment and parts shortages and difficult and lengthy negotiations over labor contracts. Productivity of existing deep mine operations has fallen off since 1968, and no new technological breakthrough is in sight that might change that trend. It is then left to the workforce and its supervision to offset the productivity loss resulting from the passage and enforcement of stringent federal and state mining regulations. If this means training methods must be inaugurated by management. It will be especially important to train the Section Foreman, for he is the main key to reversing the coal productivity trend. (DCN)

TITLE: A Program of Research, Development and Demonstration for Enhancing Coal Utilization to Meet National Energy Needs
AUTHOR: Gause, S.W., Jr. (Chairman); Rubin, S.S. (Director)

CORPORATE AUTHOR: Carnegie-Mellon University, Environmental Studies Institute
ADDRESS: Pittsburgh, PA 15213
PUBLICATION DESCRIPTION: Results of the Carnegie-Mellon University Workshop on Advanced Coal Technology

PUBLICATION DATE: 1973, October
SPONSOR: National Science Foundation, RANN Program
ABSTRACT: This report summarizes recommendations of a workshop in which experts in the field of coal technology were brought together to define the technological and fundamental information gaps in that field and to lay out a program of research to be jointly undertaken by universities, government and industry. Research needs related to coal extraction, conversion, utilization, and systems evaluation are the major areas covered in the report. (DCN)

AVAILABILITY: NTIS, PB 226 631 (\$3.00 paper copy/\$1.45 microfiche)

(CONF-740208-1) COAL MINING AND THE ENVIRONMENT. Nephew, E. A. (Oak Ridge National Lab., Tenn. (USA)). 1973. 13p. Dep. NTIS \$3.00.
From national western mining conference; Denver, Colorado, USA (9 Feb 1974).

The vast bulk of the U. S. coal resource lies at depths which render it forever inaccessible to recovery by surface mining methods. In the long term, underground mining must become the predominant form of coal extraction. The longwall method of mining shows great potential promise for increasing resource recovery and labor productivity, and for providing safer working conditions. Adverse environmental impacts from deep mining include acid mine drainage, surface subsidence, and gob disposal. Sufficient quantities of coal lie close enough to the surface that surface mining will continue to be a major factor in coal production for decades to come. Full reclamation of strip-mined mountaintop lands is especially difficult and laws affecting contour mining and reclamation do not call for full reclamation and are often inadequately enforced. The modified block-cut method of mining represents one possible method for reducing the environmental damages from mountain strip-mining. Special problems occur in arid and semi-arid regions and restoration practices in flat areas should return the land to full agricultural productivity. (MCW)

CHEWING IT UP AT 200 TONS A KITE: STRIP MINING.
W. Greenberg.

Technology Review, Feb. 1973, p. 46-56.

As energy tightens, take comfort from America's immense coal reserves. But at what price exploitation?

A Program of Research, Development and Demonstration for Enhancing Coal Utilization to Meet National Energy Needs, Carnegie-Mellon Workshop, October 1973.
NSF-RA-N-73-110.

(Contact NSF Office of Public Technology Projects,
Room 405, or RANN Document Center, Room 601,
1800 G St. N.W., Wash., D.C. 20550.)

TITLE: Bituminous Coal Data, 1972 Edition
CORPORATE AUTHOR: National Coal Association,
Economics and Statistics Division
ADDRESS: 1130 Seventeenth Street, NW, Washington,
DC 20036

PUBLICATION DESCRIPTION: Twenty-third Edition.

PUBLICATION DATE: 1973

ABSTRACT: This report presents basic data on the U.S. bituminous coal industry and related industrial and energy segments of the economy. Most of the latest data available for publication was for the year 1971, and in some instances data are available only through 1970. Information, tables, and graphs are presented under the following main headings: Salient Statistics; Production; Manpower & Safety; Machines & Efficiency; Cleaning, Crushing, & Drying; Value & Prices; Coal Markets & Stocks; Coke & Steel; Reserves; and Energy Production & Fuel Use. (MPC)

AVAILABILITY: National Coal Association (\$10.00)

(WASH-1281-2) MINING: COAL AND OIL SHALE.
Subpanel Report II Used in Preparing the AEC Chairman's Report to the President. Schmidt, W. B. (USAEC, Washington, D. C.). 27 Oct 1973. 242p. Dep. NTIS \$15.25.

Coal and oil shale together constitute 90% of our fossil fuel energy reserves. If these resources are to fulfill the expanding role demanded of them, better mining technology must be developed. This is the research area dealt with by this subpanel. Three subprograms are presented: "surface coal mining", "underground mining", and "oil shale mining". Research for the three subprograms is recommended on the principal problem areas of mining systems, environmental protection, social and economic effects, and resource recovery. The overall objective of the recommended coal and shale research mining program is the rapid development and demonstration of technology to satisfactorily mine these important energy sources. This technology must meet the required demands at acceptable costs with minimal environmental impacts. Also, this mining must be done in a manner that assures miners' health and safety and makes wise use of these resources. In the near term, the coal surface-mining segment of the program will concentrate on improving extraction/reclamation technology to allow acceptable mining of both Eastern and Western coals at the unprecedented rates anticipated. In the near term, the underground coal mining portion of the program will concentrate on the development of improved underground mining methods to provide a viable complement to our surface coal mining capabilities. The oil shale mining program will concentrate on mining of thick Western shale deposits in a manner that complements emerging government/industry efforts to develop these reserves in an environmentally acceptable manner. (auth)

COAL POLICY ISSUES. Part 1. Hearings Before the Committee on Interior and Insular Affairs, United States Senate, Pursuant to S. Res. 45, a National Fuels and Energy Policy Study, Ninety-Third Congress, First Session, on the Present and Future Role of Coal in Future Energy Supplies, June 6, 7, and 8, 1973. Washington, DC; Committee on Interior and Insular Affairs (1973). 705p. GPO.

The hearings were conducted to assist members of the Committee on Interior and Insular Affairs of the U. S. Senate to understand the issues inherent in the formulation of a long-term national energy policy that assures the continued welfare of the nation, including balanced growth, safeguarding and enhancing the quality of the environment, and national security. Statements were heard from university personnel, federal and state senators, utility personnel, environmental agencies, and many other contributors. Natural gas, tar sands, synthetic fuels, and nuclear power are discussed as options. Environmental considerations will be the key to the determination of the role of coal in the future energy supply pattern. Communications sent to industrial organizations by U. S. senators are published in which the companies were asked to submit views on coal policy issues. (MCW)

COAL POLICY ISSUES. Part 2. Hearings Before the Committee on Interior and Insular Affairs, United States Senate, Pursuant to S. Res. 45, a National Fuels and Energy Policy Study, Ninety-Third Congress, First Session, on the Present and Future Role of Coal in Future Energy Supplies. Washington, DC; Committee on Interior and Insular Affairs (1973). 573p. GPO.

The hearings were conducted to assist members of the Committee on Interior and Insular Affairs of the U. S. Senate to understand the issues inherent in the formulation of a long-term National Energy Policy that assures the continued welfare of the Nation, including balanced growth, safeguarding and enhancing the quality of the environment, and national security. Statements concerning the present and future role of coal in future energy supplies are published from fuel company officials and governmental officials in answer to a questionnaire from committee members. Much information is included on the technology available to burn coal under environmentally acceptable conditions at cost levels competitive with other fuels in fluidized-bed furnaces. (MCW)

(CONF-731027-2) REPORT ON COAL RESEARCH IN THE UNITED STATES. (National Coal Association (USA)). 1973. 21p.

The research on coal involves the government, private and public associations, private non-profit groups, and universities. The research programs underway for each agency are discussed. The mining of coal and the problems connected with the procedures are summarized. Gasification and liquefaction are stressed. Combined power cycles, binary cycles, and open-cycle MHD systems fired by clean, low-Btu coal gas provide for near-term solution to the energy crisis. OCR's power generation objectives include development of low-Btu gasification systems, MHD central station systems, and fluidized bed combustion systems. Funding for environmental control studies is delineated. (MCW)

(CONF-731027-4) REPORT ON STATUS OF FEDERALLY SUPPORTED COAL RESEARCH IN CANADA. (Department of Energy, Mines and Resources, Ottawa, Ontario (Canada)). 1973. 8p.

Predictions indicate increased coal research and development are necessary because coal production will have to increase more than four-fold (to 100 million tons per year) by the end of this century to fulfill its share of Canada's energy needs. Federal participation in coal research may continue to be more extensive than for other fossil fuels because current poor levels of return on investment in the coal industry curtail funds available for research activities. The Federal government currently supports research, technical advice, problem-solving studies, and laboratory services that cannot be carried out by other agencies. (MCW)

(CONF-731027-3) REPORT ON COAL RESEARCH IN WESTERN EUROPE. (European Coal Producers Association, Brussels (Belgium)). 1973. 35p.

From International coal research conference; Washington, District of Columbia, USA (16 Oct 1973). The report covers information from the West European countries on the organization and financing of technical research and on the major current and envisaged research projects of coal. The report covers organization of coal research in the West European countries of Belgium, France, Federal German Republic, United Kingdom, and the European Communities; current research in 1972, expenditure on current research, and focal points of envisaged research for the future; and the financing of coal research. Appendix 1 includes a systematic catalogue of research sectors and Appendix 2 is a list of research establishments shown separately for each country. (MCW)

N74-15684# Committee on Interior and Insular Affairs (U. S. Senate).

FACTORS AFFECTING THE USE OF COAL IN PRESENT AND FUTURE ENERGY MARKETS Washington GPO 1973 46 p refs Presented to Comm. on Interior and Insular Affairs, 93d Congr., 1st Sess., 1973 Prepared by Library of Congr.

Avail: Comm. on Interior and Insular Affairs A background paper to inform members of Congress on the factors affecting the use of coal in present and future energy markets is presented. The subjects discussed are: (1) coal reserves, (3) mining regulations, (4) air pollution control for coal burning utilities, and (5) the policy issues which must be considered in the Federal government for adequate exploitation of coal supplies. Tables are included to show yearly consumption, forecasts of 1980 demand, potential domestic supply available, and coal characteristics by states. P.N.F.

1973

TITLE: Regulation of Surface Mining, Part I
 COMPLETE AUTHOR: U.S. House of Representatives,
 Committee on Interior and Insular Affairs,
 Subcommittee on the Environment; U.S. House
 of Representatives, Committee on Interior and
 Insular Affairs, Subcommittee on Mines and
 Mining
 PUBLICATION DESCRIPTION: Committee Print Serial
 No. 93-11, Hearings on H.R. 3 and Related
 Bills Relating to the Regulation of Surface
 Mining, held April 9, 10, 16, and 17, 1973,
 and May 14 and 15, 1973, 863 p.

PUBLICATION DATE: 1973
 ABSTRACT: The texts of the following bills are
 included in this publication: H.R. 3; H.R.
 181; H.R. 726; H.R. 1000; H.R. 1411; H.R.
 1603; H.R. 2380; H.R. 2425; H.R. 2861; H.R.
 3518; H.R. 4863; H.R. 5651; H.R. 5998; H.R.
 6603; and H.R. 6709. All of the bills are
 concerned with either the regulation of
 surface mining or land reclamation after
 mining. The remainder of the publication
 contains statements from a large number of
 people concerning the proposed bills. (MPC)

U.S. Congress. Senate. Committee on Interior and Insular Affairs.
 REGULATION OF SURFACE MINING OPERATIONS. HEARINGS, Ninety-
 third Congress, First Session, on S. 425, a Bill to Provide for
 the Cooperation Between the Secretary of the Interior and the
 States With Respect to the Regulation of Surface Mining
 Operations, and the Acquisition and Reclamation of Abandoned
 Mines, and for other purposes, S. 923, a Bill to Provide for the
 Cooperation Between the Federal Government and the States With
 Respect to Environmental Regulations for Mining Operations, and
 for other purposes. Washington, U.S. Govt. Print. Off., 1973.
 2 v. in 1 (1410 p.)

Hearings held March 13-16, 1973.

INDUSTRIAL COME-BACK FOR COAL.
 D. Clutterbuck.
 New Scientist, Apr. 5, 1973, p.17-20.

1973

"A Report of the Study Committee on
 the Potential for Rehabilitating
 Land Surface Mined for Coal in the
 Western United States", National
 Academy of Sciences, August, 1973.

Dragos, John, "Coal Industry Problems",
 paper presented at the American Society
 of Mechanical Engineers Energy Crisis
 Symposium, Columbus, Ohio, May, 1973.

1973

SHALL WE STRIP-MINE IOWA AND ILLINOIS TO AIR-CONDITION
 NEW YORK?

FARMING AND MINING.

THE LAST OF THE WEST. (At home with the stripper).

The Atlantic, v.232, no.3, Sept.1973, p.84-103.

1973

CN-129,765

N74-15230 Geological Survey, Washington, D.C.

COAL

Paul Averitt *In its US Mineral Resources* 1973 p 133-142
 refs (For availability see N74-15214 06-18)

World coal resources are estimated to total 16,830 billion tons, of which 9,500 billion tons is classed as identified, and 7,330 billion tons is classed as hypothetical. The United States contains about one-fifth of estimated total world resources. On a uniform Btu basis, U.S. coal resources are larger than the combined domestic resources of petroleum, natural gas, oil shale, and bituminous sandstone. The prolonged future need for energy in ever increasing quantities, and the prospect of decreasing availability of and increased prices for petroleum and natural gas, have focused very sharp attention on coal as an alternative source of synthetic gas, liquid fuels, and lubricants. Author

COAL: THE STOPGAP FUEL--MAYBE.

J.H. Douglas.

Science News, v.104, July 7, 1973, p.10-12.

This is the second article in a series on the energy crisis. After covering fuel shortages and temporary solutions, the series will discuss nuclear and solar sources as long-range remedies.

COAL: THE ONCE AND FUTURE KING. Fri, R. W.
 (Environmental Protection Agency, Washington, DC). Combustion;
 5: No. 3, 8-10(Sep 1973).

The conflict between coal use and the Clean Air Act, the rising US energy demands, and the limited future supply of oil and gas as compared with coal reserves, and the need for the wisest possible use of US fossil fuel resources are discussed. (LCL)

CN-129,989
 1973
THE POTENTIAL FOR ENERGY CONSERVATION. SUBSTITUTION FOR SCARCER FUELS. A Staff Study. (Period covered: 1973-1985). Jan. 1973. 54p. & apps.

**Executive Office of the President
 Office of Emergency Preparedness**

Energy conservation

Power sources

Fuels, Oil

Coal

(Coal for oil and gas)

189,652/18
 L-9-28-73

1973

TITLE: The Western Kentucky Coal Industry - An Economic Analysis
AUTHOR: Harvey, C.K.; Karst, P.J.
CORPORATE AUTHOR: University of Kentucky, College of Engineering, Institute for Mining and Minerals Research

ADDRESS: Lexington, KY 40508

PUBLICATION DESCRIPTION: Report No. WKY

TS76-73-TM81, 88 p.

PUBLICATION DATE: 1973. May

ABSTRACT: This study analyzes the economic structure of the Western Kentucky Coal Industry. The study proceeds against the framework of traditional demand and supply analysis and examines market distributions and share for Western Kentucky coal as well as productivity and market concentration in mining. The ultimate purpose of the study is to provide an analytical basis for further, more specific research on issues related to the coal industry. (Auth)
AVAILABILITY: ORES Publications, College of Engineering, University of Kentucky, Lexington, KY 40506

(CONF-731027-1) REMARKS BY GEORGE FUMICH, Jr., ACTING DIRECTOR. Fumich, G. Jr. (Office of Coal Research, Washington, D. C. (USA)). 1973. 14p.

Progress is reported by the Office of Coal Research in the USA on the cooperation of associations, industries or industry groups, and universities. The sharing of the funding has enhanced the program. The technologies discussed include liquid fuel from coal, high- and low-Btu gas from coal, and improved direct combustion systems. Advanced coal technologies include plans to investigate bottoming cycle power generation as well as work on a molten salt combustion/gasification system. Magnetohydrodynamics is an advanced method applicable to generating electricity from coal. (MCW)

Technology Review, v.76, no.2

Dec.
1973

THE ENERGY CRISIS - special issue.

The Challenge and
Promise of Coal
Edmund A. Nephew

20

Most U.S. coal lies beneath the reach of strip mining. But we have concentrated our technology—and our exploitation—on that small share of this immense resource which is accessible from the surface

L-3-1-74

WESTERN COAL: DOES THE DEBATE FOLLOW IRREVERSIBLE COMMITMENT?

R. Gillette.

Science, v.182, Nov.2,1973, p.456-458.

ENERGY VS. THE ENVIRONMENT IN MONTANA.

New Scientist, July 26,1973, p.186,187.

The U.S. desperately needs new energy supplies; but Montanans, who live on top of incredibly rich coal deposits, want to preserve their environment from strip miners.

U. S. Energy Outlook: Coal Availability. 1973. National Petroleum Council. 1625 K Street, N.W., Washington, D. C. 20006. 287 pp., paper. \$18.00.

This is one of a series of task-group reports of the committee on U. S. energy outlook of the National Petroleum Council. These reports include methodology, data, illustrations, and computer-program descriptions. This report on coal availability is divided into the following sections: (1) summary and conclusions, (2) demand for coal, (3) coal resources, (4) coal mining, (5) future coal supply outlook, and (6) potential future coal utilization. The appendices include data on U. S. coal consumption and exports; coking coal requirements; coal reserves of the U. S.; selected U. S. coal industry statistics; an economic model of U. S. coal industry; rail transport of coal; coal-slurry pipelining in the western U. S.; electric power generation from coal; manufacture of pipeline gas from coal; and manufacture of hydrocarbon liquids from coal.

Special Purpose Coals—Selection of Coals for the Avco Hydrogen Plasma Arc Process for Making Acetylene
 Issued August, 1973
 R&D Report No. 61—Interim Report No. 5
 Contractor: The Pennsylvania State University
 Refer to: Titled report and GPO Catalog No. I63.10:61/
 Int. 5 and Stock No. 2414-00061
 Price: \$0.50

Special Purpose Coals—Preparation of Molecular Sieve Materials from Anthracite
 Issued August, 1973
 R&D Report No. 61—Interim Report No. 6
 Contractor: The Pennsylvania State University
 Refer to: Titled report and GPO Catalog No. I63.10:61/
 Int. 6 and Stock No. 2414-00002
 Price: \$0.85

**N74-19047# Sandia Labs., Albuquerque, N.Mex.
 FRACTURE OF COAL AND OIL SHALE FOR IN SITU
 PROCESSING OR REMOTE REMOVAL: A PROPOSAL
 SUPPORT DOCUMENT**
 L. D. Tyler and W. D. Weart Oct. 1973 17 p refs
 (Contract AT(29-1)-789)
 (SLA-73-946) Avail: NTIS HC \$3.00
 The proposal sets forth the concept of using the synergistic effects of a combination of hydraulic and explosive techniques to fracture these formations in a controlled manner.
 Author (NSA)

Special Purpose Coals—Structure and Properties of Various Coal Chars
 Issued May, 1973
 R&D Report No. 61—Interim Report No. 3
 Contractor: The Pennsylvania State University
 Refer to: Titled report and GPO Catalog No. I63.10:61/
 Int. 3 and Stock No. 2414-00058
 Price: \$0.65

Special Purpose Coals—Porosity in American Coals
 Issued May, 1973
 R&D Report No. 61—Interim Report No. 4
 Contractor: The Pennsylvania State University
 Refer to: Titled report and GPO Catalog No. I63.10:61/
 Int. 4 and Stock No. 2414-00059
 Price: \$0.95

**The role of coal in meeting future energy needs. R. V. Price (Nat. Coal Assoc., Washington, D.C., USA).
 6th Annual Promoters of Power Technology Conference, Stillwater, Okla., USA, 10-11 Oct. 1973 (Stillwater, Okla., USA: Oklahoma State Univ. 1973).
 p.3/1-14 (no refs.)**

**74V11538 1973 ISS OC TN805.M9P77 333.82 LC-73-623225
 PUBLIC FORUM MONTANA COAL AND ENERGY DEVELOPMENT, HELENA, MONTANA,
 FEBRUARY 3-4, 1973. EDITED BY RICHARD L. REESE.
 MONTANA COMMITTEE FOR THE HUMANITIES, UNIVERSITY OF MONTANA,
 MISSOULA. 137 L. 28 CM.
 COVER TITLE. PAPERS FROM A FORUM ORGANIZED BY A GROUP OF HELENA
 CITIZENS.
 LC COAL MINES AND MINING -- MONTANA -- CONGRESSES. POWER RESOURCES
 -- MONTANA -- CONGRESSES. POLLUTION -- MONTANA -- CONGRESSES.
 ADDED N*US*MT REESE, RICHARD L., ED. MONTANA COAL AND ENERGY
 DEVELOPMENT.
 MAIN-TITL TRACE-TITL*AUTH* CATLG BY-LC**

1973

TITLE: Low Sulfur Coal: A Revision of Reserve and Supply Estimates
AUTHOR: Nieber, M.
CORPORATE AUTHOR: University of Illinois, Urbana-Champaign, Center for Advanced Computation
ADDRESS: Urbana, IL 61801
PUBLICATION DESCRIPTION: CAC Document No. 88, 36 p.
PUBLICATION DATE: 1973, November 30 (Revised version)

SPONSOR: National Science Foundation
ABSTRACT: Several current alternatives for estimating coal resources and reserves are compared. It is shown that the heat content as well as the sulfur content of the coal must be considered in estimating reserves. Using conventional methods, estimates of known resources and recoverable reserves of low sulfur coal are grossly overstated. The relationship between coal prices and reserve/resource estimates is examined, and the effect of mine safety and strip mining legislation on coal production is also considered. Policy options and alternatives for the short and long term are discussed. (MPC)

HAS COAL A FUTURE?

M.J. Parker.

Engineering, v.213, no.1, p.38,39, Jan.1973.

Coal does have a future both in the UK and in the enlarged European Community and can make a vital and continuing contribution to energy requirements.

TITLE: Coal Supply for Gasification Plants
AUTHOR: Weir, J.P.
CORPORATE AUTHOR: Paul Weir Co.
PUBLICATION DESCRIPTION: Mining Congress Journal, 59(12), 24-28

PUBLICATION DATE: 1973, December
ABSTRACT: From consideration of economics and logistics, it is apparent that the first coal gasification plants will use the stripable coal reserves in North Dakota, Montana, Colorado, and New Mexico. These plants will use the large process and produce about 250 million cu ft per day of gas. The land reclamation involved is not too expensive. The plants will be located close to the mines. (JNC)

1973

N74-16627# National Environmental Research Center, Research Triangle Park, N.C. Control Systems Lab.
PROCEEDINGS, COAL COMBUSTION SEMINAR
 Robert E. Hall and David W. Pershing Sep. 1973 305 p refs
 Seminar held at Res. Triangle Park, N.C., 19-20 Jun. 1973
 (PB-224210/5GA; EPA-650/2-73-021) Avail: NTIS HC \$7.00 CSCL 218

The proceedings document the 10 presentations made during the Seminar, which dealt with subjects related to EPA's research and development activities for control of air pollutant emissions from the combustion of pulverized coal. The Seminar was divided in two parts: participating in the portion on fundamental research were Rockwell International's Rocketdyne Division, KVB Engineering, Inc. and Southern California Edison Co., EPA Holland's International Flame Research Foundation, and Jet Propulsion Laboratory; and taking part in the portion on pilot- and full-scale tests were Babcock and Wilcox (Alliance Research Center), U.S. Bureau of Mines, Esso Research and Engineering Co., Combustion Engineering, Inc., and Tennessee Valley Authority. Purpose of the Seminar was to provide contractors and industrial representatives with the latest information on coal combustion research.

GRA

N74-10113# Bureau of Mines, Pittsburgh, Pa. Energy Research Center.

AN ALGORITHM FOR CALCULATING MULTIPHASE CHEMICAL EQUILIBRIUM

F. E. Spencer, Jr. and A. A. Orning 1973 45 p refs
 (BM-R1-7786) Avail: NTIS HC \$4.25

A complete mathematical description is provided of the algorithm employed by a general multiphase chemical equilibrium program developed particularly for the purpose of studying problems in coal combustions, although the generality of the program will allow its application to any equilibrium system in which an appreciable gas phase is present. When applied to coal combustion problems, the program predicts composition and quantity of slag and unconsumed carbon phases as well as calculates accurately the composition of the gas phase including trace species such as free electrons and ions which are important for predicting electrical properties.

Author

KINETICS OF COMBUSTION OF A PULVERIZED BROWN COAL CHAR BETWEEN 630 AND 2200°K.

R.J. Hamor, I.W. Smith, And R.J. Tyler.
 Combustion & Flame, v.21, p.153-162, 1973.

73-WA/Fu-1 ■ Western Coals—Laboratory Characterization and Field Evaluations of Cleaning Requirements, by G. F. Moore, Assoc. Mem. ASME, Babcock & Wilcox Research Center, Alliance, Ohio, and R. F. Ehler, Mem. ASME, Diamond Power Specialty Corp., Lancaster, Ohio. (To be published in Trans. ASME—J. of Fluids Engrg.)

Many discussions have pointed out the differences in the characteristics of eastern and western coals. Low rank western coals have higher moistures, lower calorific values, and the ash constituents are more basic. Slagging and fouling indexes based on the ash chemistry of eastern bituminous coals are not applicable for low rank western coals. These differences led to dissimilarities in the behavior of eastern and western coals, so we have directed our efforts toward a study of the behavior of low rank western coals and how they differ from eastern coals.

Three nonroutine laboratory tests: (a) burning profiles, (b) coal ash sintering strengths, and (c) viscosity temperature relationship of coal ash were used to distinguish the difference in the behavior of these coals.

Three generating stations were selected to compare slagging and fouling predictions with soot blower performance. The coals burned at these stations were: 1) a North Dakota lignite, 2) a Montana subbituminous

coal, and 3) an Illinois bituminous coal.

Excellent results were noted as the observed soot blower performance and the performance predicted by an evaluation of the slagging and fouling characteristics of the coals were in agreement.

73-WA/Fu-2 ■ Further Studies of the Combustion of Pulverized Char and Low-Volatile Coal, by J. J. Demeter, C. R. McCann, and D. Blenstock, Mem. ASME, U. S. Dept. of the Interior, Bureau of Mines, Pittsburgh, Pa.

Pulverized char was fired in a dry-bottom, front-wall-fired furnace, capable of burning about 500 lb of the material per hour. Earlier experiments with chars injected at ambient temperatures into this furnace had indicated that increasing amounts of supplementary fuel (natural gas) were required to maintain good combustion as the volatile matter of the char decreased with standardized conditions of burning rate, excess air, and primary air to fuel ratio.

In this investigation, the char-primary air mixture was preheated to eliminate the need for a dual fuel system. Effects of operating parameters such as secondary air preheat and fuel particle size were studied.

A low volatile (5 percent) char was

burned successfully without supplementary fuel at a char preheat temperature of 450-500 F and a secondary air temperature of 600 F.

A char preheat temperature of 550 F was required to obtain stable combustion without auxiliary fuel when the secondary air temperature was lowered to 500 F. Low-volatile (18 percent) Pocahontas coal could be burned in the experimental combustor without either auxiliary fuel or preheat of the coal, thus giving an indication of the order of difficulty in burning low-volatile char.

73-WA/Fu-4 ■ Burning Western Coals in Northern Illinois, by R. H. Holyoak, Commonwealth Edison Co., Chicago, Ill.

Commonwealth Edison's experiences with burning Western low sulfur coals is reviewed. Edison has been burning Western coals since 1969 and will burn seven million tons in 1973. The paper discusses three areas of problems caused by using Western coal in equipment designed to burn Midwestern coals.

Combustion problems, which cover loss of capacity, carbon carryover, and fouling experience in pulverized and cyclone boilers, loss of efficiency in precipitator operation, and problems experienced with ash handling

Southwest Energy Study. Summary Report.

Southwest Energy Federal Task Force. Nov 72, 285p Paper copy also available in set of 14 reports as PB-232 095-SET, PC\$70.00.

PB-232 096/8WE PC\$6.25/MF\$1.45

With prospects of extensive large-scale development of Colorado River Basin coal, the public has raised many serious questions concerning the environmental impacts that could result. The Federal Government owns or holds in trust for the Indians the major portion of the land in the Southwest and shares the public environment concerns. The purpose of the study was to develop an information base and public dialogue that would guide needed early decisions and identify the additional new information and alternatives required to facilitate future decisions involving long-term choices. This report is a summary of the results of the Southwest Energy Study.

Southwest Energy Study. Appendix J. Coal Resources. Southwest Energy Federal Task Force. Jan 72, 220p Paper copy available only in set of 14 reports as PB-232 095-SET, PC\$70.00.

PB-232 106/5WE MF\$1.45

Contents: Coal resources and reserves of the Southwest United States; Composition and trace-element content of coal and power plant ash; Trace element content of the soils and vegetation in the vicinity of the Four Corners Power Plant.

TITLE: Exploration and Development of Coal Resources 1970-1975

AUTHOR: Bissler, H.E.

CORPORATE AUTHOR: U.S. Dept. of Interior,

Geological Survey

PUBLICATION DESCRIPTION: Paper published in 1972

Proceedings of the Mineral Economics

Symposium, part of Quarterly of the Colorado

School of Mines, "Future Energy Outlook",

69(2), p. 75-79

PUBLICATION DATE: 1973, April

ABSTRACT: This paper briefly discusses the growth in exploration for coal, future use of coal, tapped and untapped coal deposits, increase in costs and risks of mining, and regulations on land reclamation and oxide emissions that will make some reserves unminable. Coal exploration seems certain to accelerate during the next few years. (MPC)

AVAILABILITY: Colorado School of Mines, Golden, CO (\$6.00 for entire volume)

N74-16658 Peabody Coal Co., St. Louis, Mo.

BALANCING THE DEMAND AND SUPPLY OF COAL

Thomas M. Lydon *In* Denver Univ. Balancing Supply and Demand for Energy in the US 1972 p 107-114 (For availability see N74-16651 07-34)

An analysis of coal supplies for energy applications was conducted to determine methods of obtaining a balance between supply and demand. The problems faced by the coal producer and those of the coal user are examined to show the environmental impacts. Methods for meeting the energy shortages through improved coal utilization are proposed. A table is included to show the total demand for U.S. coal (including exports). Author

COMING THE GREAT COAL CLEANUP.

J.N. COVEY AND J.H. FABER.

Mech. Eng., Apr. 1972, p.38-41.

Environmental damage can be greatly reduced thru effective methods of sulfur oxide control and fly ash recovery.

THE COAL INDUSTRY MAKES A DRAMATIC COMEBACK.
Business Week, Nov. 4, 1972, p.50-55, 58.

Demand will climb to 1-billion tons a year.
Taking over for dwindling gas and oil.

COAL: CONFRONTATION.

Forbes, Nov. 15, 1972, p.32, 33, 34, 41, 42, 46.

What happens when environmentalism confronts economics?

(CONF-730432-1) OPPORTUNITY COSTS OF LAND-SCAPE MODIFICATION BY COAL SURFACE MINING. Spore, R. L. (Oak Ridge National Lab., Tenn.). 1972. 16p. Dep. NTIS \$3.00.

From 3rd Mid-Atlantic Regional Science Meeting, Syracuse, New York, USA (28 Apr 1973).

A framework is developed for determining preferred land use in the case when alternative land uses are incompatible and one of the uses involves the preservation of the natural environment in order to ensure a flow of goods and services of the public goods type. Another framework applies for an area possessing not only stripable reserves of coal but natural features of value for outdoor recreation. An economic evaluation is made of the basin of the Big South Fork of the Cumberland River in Tennessee, USA. (JCW)

1972

TITLE: Underground Coal Mining Faces Technologic Transition in Decade Ahead
AUTHOR: Queller, W. J.
CORPORATE AUTHOR: Kaiser Steel Corp., Sannyside Mines
ADDRESS: Sannyside, MT
PUBLICATION DESCRIPTION: Mining Engineering, 24(10), 59-62
PUBLICATION DATE: 1972, October
ABSTRACT: The U.S. coal industry is beginning to use underground mining procedures which have been developed in other parts of the world. The advantages of such systems as the continuous pillar and the conventional longwall are pointed out. Mining equipment has been improved recently with more efficient machinery; however, more pneumatic and hydraulic systems are needed. The U.S. Bureau of Mines is now giving active support to the mining companies. (JMC)

TITLE: Peabody Looks at the Future of Surface Coal Mining
CORPORATE AUTHOR: Mining Engineering
ADDRESS: 305 E. 47th St., New York, NY 10017
PUBLICATION DESCRIPTION: Mining Engineering, 24(10), 53-56
PUBLICATION DATE: 1972, October
ABSTRACT: The advantages of surface mining, both contour mining and area mining, are outlined. The development of equipment used for each type is described. Improved methods of land reclamation are being practiced by the coal industry. Extensive area mining of coal in the western U.S. will undoubtedly be carried out in the immediate future. Coal gasification will increase the demand for this supply. (JMC)

TITLE: Survey Measures Impact of Health Safety Act on Underground Coal Mining
AUTHOR: Stratton, J. W.
CORPORATE AUTHOR: Gates Engineering Co.
ADDRESS: P.O. Drawer AP, Rectley, WV 25801
PUBLICATION DESCRIPTION: Mining Engineering, 24(10), 64-67
PUBLICATION DATE: 1972, October
ABSTRACT: A detailed statistical analysis of the cost and safety of the Federal Coal Mine Health and Safety Act of 1969 was compiled, based on replies from 68 of the largest mines in the country. The analysis was difficult, due to the variety of record keeping methods and the variety of mining conditions encountered. Various tables are given which show the increased costs as functions of seam height, type of haulage, mine size, ownership, and location. Most companies reported increased ventilation requirements as the largest single added cost. (JMC)

1972

TECHNOLOGY AND USE OF LIGNITE. Proceedings of a Conference Held at Bismark, North Dakota, May 12-13, 1971. Kube, W. R.; Elder, J. L. (comps.). Bureau of Mines Information Circular 8543. Washington, DC: Bureau of Mines (1972). 145p. GPO \$1.50.

The proceedings at the symposium included the following papers: A Progress Report on coal mine health and safety; pipeline transport of "liquid" coal; liquefaction of lignite with carbon monoxide and water; use of western coal and air-water quality control; relationship of air quality measurements to criteria and emission standards; nitrogen oxides, sulfur oxides, and particulate control technology for fossil fuel combustion; low gas temperature solution to high resistivity ash problems; collecting fly ash from western low-sulfur coals; pilot study of electrostatic precipitation for removing fly ash at basin electric's Leland Olds Station; future energy supply: approaches and options; lignite and the cyclone burner in a new 235-Mw generating station, and detailed construction and equipment costs for the 235-Mw Milton R. Young Generating Station. (MCW)

CE-128,766
COAL REFUSE FIRES, AN ENVIRONMENTAL HAZARD.
Lewis M. McRay. 1971. 50p.

1971

Bureau of Mines

Inf. Circular 8515

Coal
Air - Pollution
Fire prevention

TK2896.I5 1969

THE WESTERN COAL DEPOSITS: A NATIONAL SOURCE OF POWER. M. Steinberg, J. Powell, and B. Manowitz. Brookhaven Nat. Lab.
4th Intersociety energy conversion engineering conference, Wash, D.C., Sept. 22-26, 1969, p.188-206.

The need, technology, and economics of a national energy system based on the vast western coal reserves are described. Large western-based MHD power generating plants feeding power to 50,000-MW(e) long distance cryogenic transmission lines could deliver pollution-free power to far western and eastern energy consuming load centers at 2.5 to 4 mills/kWh(e) total cost. The possibility of by-product uranium, hydrogen, heavy water, and communications could further increase the utility and economic value of the system. (auth)

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74N72634 8M-IC-8401 69/00/00 42 PAGES UNCLASSIFIED DOCUMENT
 SUPPLY AND DEMAND FOR ENERGY IN THE UNITED STATES BY STATES AND
 REGIONS, 1960 AND 1965. 1 COAL
 A/BRODERICK, G. N.
 BUREAU OF MINES, WASHINGTON, D.C. AVAIL SCD FC \$1.00
 /*DEMAND (ECONOMICS)/*ENERGY CONSUMPTION/*UNITED STATES OF AMERICA/
 COAL/ FREIGHT COSTS/ UTILITIES

CN-129,852 1968
 COAL RESOURCES OF THE UNITED STATES JANUARY 1,
 1967. Paul Averitt. (1968). 116p. (Supersedes
 Geological Survey Bulletin 1136).
 CN-126,936 1967
 EMISSIONS FROM COAL-FIRED POWER PLANTS: A COMPRE-
 HENSIVE SUMMARY. Stanley T. Curfice and Richard W.
 Gerstle. 1967. 26p.

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 1136

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 Smoke

Pub. 999-AP-35

Coal

Minerals

Earth - Resources

189,653

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CN-126,928 1966
 ATMOSPHERIC EMISSIONS FROM COAL COMBUSTION - AN
 INVENTORY GUIDE. W.S. Smith and C.W. Gruber. April
 1966. 112p.

Public Health Service

Air pollution

Coal
 Fuels - Combustion

Pub. 999-AP-24

PB 170 851
 L-12-23-70

OIL, THE DWINDLING TREASURE.

N. Grove.
National Geographic, v.145, no.6, June 1974,
p.792-825.

The world's sudden awareness of its dependence on oil prompts a new look at the diminishing resource--how we get it, how long it may last, and what happens when it runs out.

OIL FROM CANADA: SHOULD THE U. S. DEPEND ON IT. Gilbride, N.; Gilbride, J. World Oil; 178: No. 1, 47-50(Jan 1974).
The shifting of energy policies in Canada is confusing as nationalism spreads in Canada. Western Canadian oil has been piped to the U. S., even though oil was badly needed in Eastern Canada, but transportation problems made it desirable for Canada to import oil for the east. Now with rising prices and the Arab oil embargo, Canada is shipping oil by every means possible to meet Montreal's growing shortage. Canada's oil future depends on the tar sands in Alberta with estimated potential reserves of 35 billion barrels. With uncertain energy policies in the fore, even the prospect of a government-owned crown petroleum company, some Canadian independents are moving south into the United States with millions of dollars worth of drilling equipment with them. (MCW)

U.S. CRUDE PRICES SEEN STILL TOO LOW.
Oil & Gas Jour., v.72, no.21, May 27, 1974,
p.26-27.

HIGHER prices for domestic crude are necessary to reverse the decline in U.S. production capacity. Without new investment, production will decline about 10%/year, or 1 million b/d.

ERTS IMAGERY PROMISING AS PETROLEUM EXPLORATION TOOL. Saunders, D. F.; Thomas, G. E.; Kinsman, F. E. (Texas Instruments Inc., Dallas). World Oil; 178: No. 4, 83-84(Mar 1974).
Imagery obtained with ERTS-1, NASA's Earth Resources Technology Satellite, shows promise for exploration for petroleum and minerals. The vehicle was launched July 23, 1972 into a near-polar orbit. A geologic description of a 115 square mile area in West Texas-New Mexico is given. (MCW)

Science, v.184, no.4134, Apr.19,1974.

Prognosis for Expanded U.S. Production of Crude Oil: R. R. Berg, J. C. Calhoun, Jr., R. L. Whiting 331

INTERLOCKING OIL: BIG OIL TIES WITH OTHER CORPORATIONS. Fritsch, A. J. (ed.). CSPI Oil Series. Washington, DC: Center for Science in the Public Interest (1974). 52p.
There are 460 interlocking directorates and advisory committees connections of eighteen large oil companies with well-known large corporations. There are 132 interlocks with banks; 31 with insurance; 12 with utility companies; 15 with transportation corporations; 46 affiliations with educational institutions; and 224 with manufacturing and distribution corporations. (MCW)

FOREIGN OIL: A POLITICAL-ECONOMIC PROBLEM.

M.A. Adelman.

Tech. Rev., v.76, no.5, Mar/Apr.1974, p.42-47.

Agreements with the oil cartel will not be binding, nor will they avert continued turbulence in supply for the consuming nations. The author offers ways to fight the monopoly and suggests that self-interest of the individual members of the cartel may be the seed of its destruction.

OIL, SUPER-SHIPS & THE OCEANS.

J. Frye.

Oceans, v.7, no.1, Jan-Feb.1974, p.48-55.

The new generation of giant vessels and the problems of ports and pollution in their wake.

THE FAR-REACHING CONSEQUENCES OF HIGH-PRICED OIL.

Sanford Rese.

Fortune, Mar.1974, p.106-111,191,192,196,

Industry may have to use more labor and less capital--and change its product mix.

Environment & Change, v.2, no.5, Jan.1974.

WHAT PRICE PETROLEUM?

305

Our Special Correspondent

WHERE TO FIND MORE PETROLEUM

313

Our Special Correspondent

ARTIFICIAL PRICES MEAN ARTIFICIAL COMPETITION

319

Our Special Correspondent

OUR VAST, HIDDEN OIL RESOURCES.

S. Rose.

Fortune, Apr.1974, p.104-107,180,182,184.

Some archaic regulations and superstitions about "waste" are keeping us from tapping our vast, hidden oil reserves.

THE DIFFUSION OF NEW TECHNOLOGY IN THE U.S. PETROLEUM REFINING INDUSTRY.

M. Bundgaard-Neilsen and Peter Fiehn.

Technological Forecasting & Social Change, v.6, 1974, p.33-39.

The diffusion of new technology is described by a simple model. The results of a comprehensive case study of the diffusion into the U.S. petroleum refining industry based upon the model is presented.

The Supply of Domestic Petroleum

The production of crude oil in 1973 was 9.2 million barrels per day. The total consumption was about 17.0 million barrels per day, which included about 6.1 million barrels per day of imports, and 1.7 million barrels per day of natural gas liquids. To raise production to higher levels by 1980 would require prodigious exploration and development, as an appraisal of present conditions and forecasts shows.

Technology Review, v.76, no.6, May 1974, p.47-

The U.S. and the World Oil Market

The price of imported oil is an important factor in the analysis of U.S. energy policy. The world price determines the resource cost of oil from abroad, and one of the goals of independence is to avoid a large economic drain for energy imports. Moreover, the world price is an important determinant of domestic price, and thus of the incentives to domestic demand and supply.

KEY ISSUES IN OFFSHORE OIL.
J.W. Devanney III.
Technology Review, Jan.1974, p.21-23.

Environment, v.16, no.2, Mar.1964.

THE OIL GLUT

A Statement by the Scientists' Institute for Public Information

Genuine concern about long-term energy supplies has been manipulated to justify artificial immediate shortages.

Environment, v.16, no.2, Mar.1974.

OIL AND THE POOR COUNTRIES

Center for Economic and Social Information

Hardest hit by restrictions of oil supply have been the developing nations, which cannot afford fuel at present elevated prices.

Environment, v.16, no.4, May 1974, p.6-14.

OIL ON ICE

René O. Ramseier

International drilling operations in the Arctic will produce oil spills that could result in melting ice and global weather change.

1974

The Limits to Kentucky Coal Output: A Short-Term Analysis.
 Stuart A. Schweitzer.
 Kentucky Univ., Lexington. Coll. of Engineering. Feb 74,
 31p UKY-TR81-74-IMMR2
 PB-230 775/9WN PCS4.75/MF\$1.45

While the demand for Kentucky coal and market prices have increased dramatically in recent months, the capacity of the Kentucky coal industry to increase its output is seriously limited in the near term. This report attempts to identify current coal industry problems which may influence the level of coal output in the next year or two and to estimate by how much Kentucky coal output may be expected to rise during that period. The analysis for this report is based upon conversations with coal industry spokesmen as well as with representatives of state government and the coal-hauling railroads.

An Evaluation of the Mandatory Petroleum Allocation Program. A Staff Report to the Federal Trade Commission.
 Federal Trade Commission, Washington, D.C. 15 Mar 74,
 1012p FTC-R-6-15-21
 PB-231 032/4WE PCS19.00/MF\$1.45

This report presents the findings and conclusions of the Commission staff based on a study, mandated by Congress, of the Emergency Petroleum Allocation Act (1973) and Regulations, and an analysis of the allocation program carried out under the Regulations from the date of their issuance on Jan. 15, 1974, through Feb. 28, 1974. The report reviews the background and key provisions of the Act and Regulations; evaluates the effectiveness of the allocation program; and assesses the administration of the program by the FEO during its first 45 days. Technical appendices to the report contain an historical perspective to the current situation; findings from field investigations on the operation of FEO Regional and State Allocation Offices; and a number of individual case studies of FEO and states' responses to consumer and industry problems.

THE NEW SHAPE OF THE US OIL INDUSTRY.
 Business Week, Feb.2,1974, p.50-55,58.

Assessment of U.S. Petroleum Supply with Varying Drilling Efforts.

T. M. Garland, M. Carrales, Jr., and J. S. Conway.
 Bureau of Mines, Washington, D.C. Mar 74, 42p BuMines-IC-8634 Paper copy available from GPO \$0.75 as stock no.
 SN-2404-01537.
 PB-231 153/8WE PC-GPO/MF\$1.45

This report presents a Bureau of Mines assessment of crude oil and associated gas production and reserves that would result from different drilling efforts in the lower 48 states during the 1972-85 period. The drilling effort was based upon five growth rate assumptions from the 1971 level. Additions to crude oil reserves were computed for nine cases resulting from the use of three equations for findings per foot drilled and three constant revision factors. The results presented vividly illustrate that the United States will not become self-sufficient in crude oil production by 1985 and also illustrate the lead time required to reverse the decline in oil production. Discussion is limited to three of the nine cases to provide high, intermediate, and low results. More emphasis is on the intermediate case because it is indicative of the most probable trends. The methodology and statistical data are included in the appendices. (Author)

1974

Nature, v.249, June 21,1974, p.700-703.

North Sea oil in a world context

Frank Howitt

The British Petroleum Company Limited, Britannic House, London EC2Y 9BU, UK

Dr F. Howitt, of BP, assesses the oil and gas reserves which Britain can expect to exploit from the waters around its coastlines. Although supplies are limited, there seems to be some room for optimism: even if no more oil is discovered there may still be a small supply at the beginning of the next century.

The Oil Security System - An Oil Import Policy for the United States.
Daniel H. Newlon, and Norman V. Breckner.
Center for Naval Analyses Arlington Va Inst of Naval Studies Jan 74, 69p INS-Research Contrib-255
AD-779 283/1WE PC33.75/MF\$1.45

What should the United States do if some oil imports are cheaper but less secure than domestic energy production. In answer to this recurring question, the Oil Security System provides for more oil security and more imports too. It permits imports from insecure sources, either upon payment of a fee or if backed by commitments of emergency oil supplies issued by suppliers of secure oil. Such commitments, called guarantees, are obligations to sell on the market oil in an emergency from such sources as inventories, existing wells operated below capacity, capped wells, new wells drilled during the emergency, and diversions of U.S. exports of crude oil and refined products. In turn, possession of a guarantee is the qualification for receiving a fee-exempt import allowance. Both guarantees and fee-exempt import allowances would be bought and sold. Importers of oil would choose the cheaper way of importing between paying the fee and acquiring a fee-exempt import allowance. Under the Oil Security System the information on guarantees would at all times permit the government to maintain a detailed plan specifying where oil would come from and when it would be supplied in an emergency. In most situations, substituting an Oil Security System for an alternative import policy would both reduce the cost of importing oil and increase oil security in the form of emergency oil supplies. (Author)

IMPLICATIONS OF RECENT ORGANIZATION OF PETROLEUM EXPORTING COUNTRIES (OPEC) OIL PRICE INCREASES. Prepared at the Request of Henry M. Jackson, Chairman, Committee on Interior and Insular Affairs, United States Senate, Ninety-Third Congress, Second Session, Pursuant to S. Res. 45. A National Fuels and Energy Policy Study. Serial No. 93-35(92-71). Washington, DC; Committee on Interior and Insular Affairs (1974). 134p. GPO \$1.25.

An overview of the OPEC oil price increases is discussed after a memorandum presented by Chairman Jackson. That governmental policy responses may be counterproductive is a view presented. A discussion on implications for global governmental policy formulation precedes eight tables presenting information on Persian Gulf crude oil prices; revenues from oil exports; oil revenue picture for 11 OPEC members; net trade balances, selected countries, 1972-73; selected countries; value of oil imports; total oil revenues available to producing governments and assumed potential use of funds, 1974; international financial liquidity. selected nations, 1971-73; and oil price rise impact for selected developing countries. Five papers are presented in the Appendix on implications of exploding world oil costs; the economic consequences of the high cost of imported oil; oil and the world business cycle; energy shock and the development prospect; and the foreign-exchange market developments. (MCW)

1974

(UCID-16456) STRATEGIC STORAGE, SUPERPORTS AND SALT DOMES: A SYNTHESIS. Palmieri, T. M. (California Univ., Livermore (USA). Lawrence Livermore Lab.), 22 Feb 1974. Contract W-7405-eng-48. 26p. Dep. NTIS \$3.50.

In the U. S., there is a bill before the Senate that would establish emergency reserves of petroleum to sustain the country for at least 90 days. Storage of such reserves would be costly. If salt domes were leached to provide capacity for storing petroleum for a 90-day requirement, each facility would be about 8 million dollars, pipelines another 5 million, and the cost of the oil unknown. The arrival of large tankers involves the construction of superports to accommodate them. The proposed Texas superport will include a tank farm that will cover 100 acres. The site of the proposed superport in Louisiana is in the middle of a large field of salt domes. The import situation is discussed and recommendations to alleviate the worsening situation are listed. (MCW)

WORLD OIL OUTPUT JUMPS 9.5% IN 1973. Aulridge, L. Oil Gas J.; 72: No. 8, 34; 36-37(25 Feb 1974).

World crude-oil production set a new record in 1973 with the production of about 55.5 million bbl/day. World production reached its monthly peak for the year in September. Even with the Middle East disturbance, Saudi Arabia showed a 26.4% increase for 1973. Regional production analyses for 1973 are shown for Canada, Europe, Communist Area, United States, Latin America, Africa, Asia-Pacific Area, and the Middle East. (MCW)

CN-140,413 1974
SUPERPORT ENVIRONMENTAL PROTECTION PLAN. DEEP DRAFT HARBOR AND TERMINAL AUTHORITY. Jan. 15, 1974.

Louisiana Board of Commissioners
Deep Draft Harbor and Terminal Authority

Ports, Deep water
Water pollution
Environment

LRC 74-16
L-3-18-74

209

MILLION-TON TANKER FLEET: IS IT REALLY COMING. Spyrou, A. G.; Shimpou, Y. (Olympic Maritime, S. A., Monaco). Oil Gas J.: 72: No. 9, 58-60; 65(4 Mar 1974).

"Probably," says Andrew G. Spyrou of the Olympic Maritime, S. A., A. S. Onassis Group of Companies, Monaco, of the likelihood of the construction of the million-ton tankers. Naval architects are proceeding with designs. Experience with the quarter-tonners gives confidence that the million-tonner is feasible. The International Maritime Consultative Organization (IMCO) in dealing with pollution control has enacted that tankers over 70,000 dwt after 1980 be required to be segregated-ballast-tankers. The price for construction will be almost prohibitive says Y. Shimpou, Ishikawajima-Harima Heavy Industries Co. Ltd., Tokyo, so "unlikely", he says. Efficiency is the reason for increased size and this will be minimized due to ship cost, labor, increased insurance costs, and all facilities for building, maintenance, and mooring will be increased. (MCW)

PETROLEUM POTENTIAL OF ARCTIC CANADA.

Rudkin, R. A. (R. A. Rudkin Consultants Ltd., Calgary, Alberta). Oil Gas J.: 72: No. 10, 145-152(11 Mar 1974).

Drilling of 50 wells on the land area north of the Aklavik arch has produced mainly gas with some light oil or condensate. Oil was discovered in fault traps along the northern edge of the arch. Offshore drilling has begun, but it appears that the oil reserves discovered to date do not meet the threshold volume necessary for an oil pipeline. It is estimated that about 15 Tcf of gas has been discovered in the Beaufort Basin and does meet the threshold volume to justify a pipeline to Alberta. The geology of the Beaufort Basin is described. Arctic Islands oil will possibly be delivered to market by pipeline by 1985 and gas by 1983. (MCW)

MANY VARIABLES GO INTO PLANNING DEEPWATER TERMINAL. Dudley, R. J.; Havik, K. P. Oil Gas J.: 72: No. 9, 53-57(4 Mar 1974).

Plans for a safe and successful deepwater seadock in the United States are proceeding. Waterborne transportation will be the means for transporting the long-term oil-import requirements. Many seacoast areas are being considered and data are being compiled on wind, waves, currents, tidal movements, water depth, sea-bottom topography, and soil conditions; assessments of availability of maneuvering and anchoring areas and approach lanes, especially in relation to other ship traffic or other activities such as oil and gas exploration and production; studies of possible impacts on the environment, and economy of the regions. (MCW)

OIL AND GAS RESOURCES: DID USGS GUSH TOO HIGH? R. Gillette.

Science, v.185, July 12,1974, p.127-130.

If the U.S. Geological Survey is right, the U.S. is at least a decade away from seriously depleting its domestic oil and gas resources. But if several distinguished disbelievers are right, the U.S. is running out of oil and gas right now.

EXPERTS VIEW IMPROVED RECOVERY STATUS.

Bleakley, W. B. Oil Gas J.: 72: No. 10, 85-88; 90(11 Mar 1974). Estimates are made that improved oil-recovery methods must account for $\frac{1}{4}$ to $\frac{1}{2}$ of the U. S. future oil production. Six oil men participated in a panel discussion on how to reach that goal facing major and independent oil companies. Special significance was given to tertiary oil recovery. (MCW)

US Energy Outlook - Oil and Gas Availability (National Petroleum Council, 1625 K Street NW, Washington DC 20006, \$ 25.00, 768 pp). Background data, methodology and assumptions used in preparing the complete report are here described in detail, including the computer program used to analyse impacts of variables in future production. It constitutes a reference volume of data and projections on petroleum and natural gas production.

Iskandar, Marwan. THE ARAB OIL QUESTION. 2d ed. Beirut, Middle East Economic Consultants, 1974. 138 p.

Rifai, Taki. THE PRICING OF CRUDE OIL: ECONOMIC AND STRATEGIC GUIDELINES FOR AN INTERNATIONAL ENERGY POLICY. New York, Praeger, 1974. 356 p. (Praeger Special Studies in International Economics and Development)

A Survey of the Economic and Environmental Aspects of an Onshore Deepwater Port at Galveston, Texas. Part I. Potential Economic Effects.

Daniel M. Bragg.

Texas A and M Univ., College Station. Apr 74. 58p

TAMU-SG-74-213, NOAA-74050701

COM-74-11030/5WE PC\$6.00/MF\$1.45

In summarizing the study, the author indicates that it cannot be shown absolutely that an offshore terminal would have a cost advantage over a terminal located onshore. For this reason, cost in itself cannot be the sole determining factor in deciding the feasibility of the onshore deepwater terminal at Galveston. The economic impact of an onshore deepwater terminal at Galveston will be somewhat greater, throughout the region, than will the impact from an offshore oil terminal. In addition to the impact which could result from growth in oil refining, and supporting industry, the onshore port will have an impact of additional jobs and expenditures resulting from the operation of the port. Such things as tug hire, stevedoring, line handling and similar, port-related activities, will be of a greater magnitude than they would be at an offshore terminal.

A Survey of the Economic and Environmental Aspects of an Onshore Deepwater Port at Galveston, Texas. Part II. Environmental Considerations.

Roy W. Hann, Jr., and Wesley P. James.

Texas A and M Univ., College Station. Apr 74. 42p

TAMU-SG-74-214, NOAA-74050702

COM-74-11031/3WE PC\$5.50/MF\$1.45

The report outlines environmental aspects associated with the proposed deep draft channel from a terminus near Pelican Island to the 100 foot depth contour some 57 miles offshore in the Gulf of Mexico. The report presents some of the major environmental factors which would be affected by the project and outlines ways that the impact on the environmental components could and should be evaluated. Such environmental modifications can have both environmental costs in the form of environmental degradation or environmental benefits in the form of environmental enhancement. The project also has the potential for environmental pollution from accidental oil spills, dredge spoil disposal and other project activities, which must be considered as environmental degradation and cost.

U.S. Congress. Senate. Committee on Banking, Housing and Urban Affairs. PETROLEUM PRODUCT SHORTAGES. HEARINGS, Ninety-third Congress, First Session, on the Impact of Petroleum Product Shortages on the National Economy. Washington, U.S. Govt. Print. Off., 1973. 514 p.

Hearings held May 7-11, 1973.

AIChE Symposium Series, v.69, no.127 1973

DECLINING DOMESTIC RESERVES - EFFECT ON PETROLEUM AND PETROCHEMICAL INDUSTRY. C.H. Cummings, ed. (Contains papers presented at the 71st National Meeting of AIChE, Dallas, (Tex., 1973)).

American Inst. of Chemical Engineers

L-5-1-74

TITLE: The World Petroleum Market HD 9560.5.A 34

AUTHOR: Adelman, H.A.

CORPORATE AUTHOR: Massachusetts Institute of Technology

TECHNOLOGY: Resources for the Future, Inc.

PUBLICATION DESCRIPTION: Johns Hopkins University Press, Baltimore, MD 21218. 500 p.

PUBLICATION DATE: 1973, January 8

ABSTRACT: This is a detailed study of one of the most vital and complicated sets of economic relationships in the contemporary world, the financial arrangements for crude oil made between nations and private firms. It analyzes the world petroleum market from an astoundingly realistic viewpoint, with a sharp focus on buyer-seller psychologies, and serious concern for the effects of present U.S. energy policies. (From RPT announcements)

AVAILABILITY: From publisher or bookstores (\$22.50)

AIChE Symposium Series, v.69, no.135 1973

THE PETROLEUM/PETROCHEMICAL INDUSTRY AND THE ECOLOGICAL CHALLENGE. George H. Cummings, ed. (Contains abstracts of papers presented at the Seventy-fourth National Meeting of the AIChE in New Orleans this year).

American Inst. of Chemical Engineers

- Sec.I. Economic area.
- Sec.II. Process technology area.
- Sec.III. Marketing area.
- Sec.IV. Plant operations area.

TP
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P35
1973
Petroleum and Chemical Industry Conference, 20th, Houston, Tex., 1973.
Record of conference papers. 20th Annual Petroleum and Chemical Industry Conference, Houston, Texas, September 10, 11, 12, 1973.
New York, Institute of Electrical and Electronics Engineers, 1973.
233 p. illus. 28 cm.
Catalogue no. 73CHO769-01A.

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Offshore Technology Conference, 5th, Houston, Tex., 1973.
Preprints, volume 2.V [Dallas, Tex., Off-shore Technology Conference, 1973]
1 v. (various pagings) 28 cm.

1. Petroleum in submerged lands--Congresses.
2. Ocean engineering--Congresses.
3. Marine engineering--Congresses.

TN
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.A33
1973
Ahern, William R
Oil and the outer coastal shelf; the Georges Bank Case [by] William R. Ahern, Jr. Cambridge Mass., Ballinger Pub. Co. [1973] xiv, 133 p. illus. 24 cm.
Originally presented as the author's thesis, Harvard.
1. Petroleum in submerged lands--Georges Bank. 2. Environmental policy--Georges Bank. I. Title.

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L-3-18-74

HOW MUCH OIL IS LEFT?

H.R. Warman.
Environment & Change, Nov.1973, p.164-172.

World oil production will reach a peak at some point in the next decade and will thereafter slowly decline. The prospect that non-conventional sources of oil will quickly provide alternative supplies is slight.

GROWING DRIVE TO TAP VAST U.S. FUEL RESERVES.
U.S. News & World Rept., Apr.30,1973, p.69-71.

A White House plan, just unveiled, stresses what oil and gas men have been saying for years - given incentive, U.S. industry can find more fuel.

SUPERSHIP ERA AHEAD?

J.H. Prescott.
Chem. Engineering, Feb.19,1973, p.56,57.

The expanding energy crisis means that the U.S. will have to import lots more crude oil. Deep water ports that can accommodate supertankers are one way to cut transportation costs. Such ports could also serve as terminals for dry dock cargoes.

HOW TO REACH THAT NORTH SLOPE OIL: SOME ALTERNATIVES AND THEIR ECONOMICS.

R.A. Rice.
Tech. Rev., June 1973, p.9-18.

CONTINENTAL DRIFT AND RESERVES OF OIL AND NATURAL GAS.

D.H. Tarling.
Nature, v.243, June 1,1973, p.277-279.

THE CHALLENGE OF NORTH-SEA OIL.

W.L. Morse.
Machine Design, June 14,1973, p.18-21.

THE CASE FOR DEEPWATER PORTS. M.W. Fleck.
Exxon USA, Fourth quarter, 1973, p.12-15.

1973

THE PERSIAN GULF: US ROLE IN A STRUGGLE FOR OIL.

U.S. News & World Rept., May 21, 1973, p.90-94.

1973

PETROLEUM POLITICS AND THE MIDDLE EAST.

J. Maddox.

Environment & Change, v.2, no.2, Oct.1973, p.99-105,
109.

1973

US PETROLEUM POLICY.

Congressional Digest, Oct.1973.

CONGRESS AND FEDERAL REGULATION OF THE PETROLEUM
INDUSTRY. P.227-

PRESENT US OIL PRODUCTION AND CONSUMPTION. P.228-

THE PRINCIPAL FEDERAL AGENCIES INVOLVED. P.230-

OIL POLICY IN THE 93RD CONGRESS. P.232-

PROS AND CONS OF RELAXING THE PRESENT DEGREE OF
FEDERAL REGULATION OF THE US OIL INDUSTRY -

WOULD RELAXATION HELP F SE THE 'ENERGY CRISIS'.
P.234-

1973

THE WRONG ROUTE. C. J. Cicchetti.

Environment, v.15, no.5, June 1973, p.4-15.

The oil pipeline across Alaska was originally pro-
posed to take advantage of oil import quotas and
other regulations, which have now changed. A
route across Canada would now be more profitable,
even to the oil companies, and would be less damag-
ing to the environment.

Shwadrin, Benjamin. THE MIDDLE EAST, OIL AND THE GREAT POWERS. 3d ed.,
rev. and enl. New York, J. Wiley, 1973. 630 p. (The Shiloah
Center for Middle Eastern and African Studies. Monograph Series)

1973

(PB-224018) POTENTIAL ONSHORE EFFECTS OF DEEPWATER OIL TERMINAL-RELATED INDUSTRIAL DEVELOPMENT. Volume I. Part One. Executive Summary. Final Report. (Little (Arthur D.), Inc., Cambridge, Mass. (USA)). Sep 1973. vp. NTIS.

An assessment was made of the onshore, or secondary, effects of deepwater terminal development on each of five areas (Machias, Maine; the vicinity of Sandy Hook, New Jersey; the Delaware Bay, New Jersey; Grand Isle, Louisiana; and Freeport, Texas) selected as terminal locations. The relative suitability of each area as a terminal site is affected by the relative impacts of a terminal on the area, including the additional industrial development, production, employment, air and water pollution, land use, population changes, etc., resulting from terminal development. The terminal impacts are related to the normal cumulative effects of growth processes on various individual areas and regions in order to illustrate their apparent capacity to accommodate terminal-related growth. (NTIS)

(PB-224019) POTENTIAL ONSHORE EFFECTS OF DEEPWATER OIL TERMINAL-RELATED INDUSTRIAL DEVELOPMENT. Volume II. Part Two. Mid-Atlantic Region. Part Three. Maine. Final Report. (Little (Arthur D.), Inc., Cambridge, Mass. (USA)). Sep 1973. vp. NTIS.

An assessment was made of the onshore, or secondary, effects of deepwater terminal development of the Mid-Atlantic region and on Maine, in particular, in the vicinity of Sandy Hook, N. J., in Delaware Bay, N. J., and at Machias, Me. The relative suitability of each area as a terminal site is affected by the relative impacts of a terminal on the area, including the additional industrial development, production, employment, air and water pollution, land use, population changes, etc., resulting from terminal development. (NTIS)

(PB-224020) POTENTIAL ONSHORE EFFECTS OF DEEPWATER OIL TERMINAL-RELATED INDUSTRIAL DEVELOPMENT. Volume III. Part Four. Gulf Coast Region. Final Report. (Little (Arthur D.), Inc., Cambridge, Mass. (USA)). Sep 1973. vp. NTIS.

An assessment was made of the onshore, or secondary, effects of deepwater terminal development on the Gulf Coast region, in particular, in the areas of Grand Isle, Louisiana, and Freeport, Texas. The relative suitability of each area as a terminal site is affected by the relative impacts of a terminal on the area, including the additional industrial development, production, employment, air and water pollution, land use, population changes, etc., resulting from terminal development. (NTIS)

1973

N74-71867

(PB-224021) POTENTIAL ONSHORE EFFECTS OF DEEPWATER OIL TERMINAL-RELATED INDUSTRIAL DEVELOPMENT. Volume IV. Part Five. Appendices. Final Report. (Little (Arthur D.), Inc., Cambridge, Mass. (USA)). Sep 1973. vp. NTIS.

The Appendices contain information and data pertinent to each area study. The Appendices are as follows: I. The Petrochemical Industry; II. United States Crude Oil Imports and Refining; III. Economic Methodology; IV. Environmental Methodology. (NTIS)

TITLE: Oil Refinery Capacity
CORPORATE AUTHOR: U.S. Senate, Committee on Interior and Insular Affairs

PUBLICATION DESCRIPTION: Serial no. 93-17 (92-52), Hearing pursuant to S.Res.45, A National Fuels and Energy Policy Study, on The Basic Factors Underlying the Present Shortage of Refining Capacity in the United States, 456 p.

PUBLICATION DATE: 1973

ABSTRACT: The hearings were held to explore the reasons for the present shortage of refining capacity in the U.S. Witnesses were asked to consider twelve questions on refinery capacity, trends in consumption and production in the U.S. and abroad, and government policies. Testimony was presented by Senators and representatives of the National Petroleum Council and the Department of the Interior. Additional material received from others is included along with two publications of the National Petroleum Council. (HFG)

AMERICAN IMPORT POLICY AND THE WORLD OIL MARKET. Adelman, M. A. (Massachusetts Inst. of Tech., Cambridge). Energy Policy; 1: No. 2, 91-99(Sep 1973).

Little effect will be seen for self-sufficiency before 1980, when imports are expected to reach 10 million barrels/day. There is no danger of the U.S. bidding away scarce oil. First, it has no power to do so. The American and other multinational oil companies take orders from the producing nations, no matter who owns them. Second, oil continues as before in great potential over-supply, which the growing price-cost gap will aggravate. Price and availability of world oil unrelated to supply and demand, high prices and insecure supply, and Middle East politics irrelevant to security of price are discussed. (Note: This article was written before the Arab oil embargo). (MCW)

TITLE: Key Issues in Offshore Oil
AUTHOR: Devaney, J.V., III
CORPORATE AUTHOR: Massachusetts Institute of Technology, Dept. of Ocean Engineering
ADDRESS: Cambridge, MA 02139
PUBLICATION DESCRIPTION: Part of Report No. MIT-66 73-7, World Energy and the Oceans, Second Annual Sea Grant Lecture and Symposium, 14 p.
PUBLICATION DATE: 1973, October 18
ABSTRACT: This paper discusses some of the aspects of offshore oil which were brought out by the Georges Bank Petroleum Study. One of the issues involves the characteristics and impact of oil spills. Surveys of existing biological data show that the toxicity of some compounds of oil is several orders of magnitude greater than others. With crude oil the culpits are believed to be the soluble or light aromatics. From a detailed study of the behavior of an oil spill on the surface in the first few hours of the spill's life it appeared that oil tends to fractionate on the surface. Often this occurrence takes the form of a central "glob" surrounded by a "film." The glob contains approximately 90-95 percent of the oil and spreads much slower than the film, which occupies such a large area than the glob. It is suspected that the film contains the highly soluble, highly toxic compounds, and therefore will have the most biological impact. From the viewpoints of recreational amenities, tourism, and shorefront property values, the glob is the important factor. This study may also prove that current refinery wastewater treatment methods do nothing toward eliminating the biologically critical compounds of oil, as these methods depend on gravity separation. The economic analyses of the Georges Bank study brought out that offshore petroleum can be cheap and that the loss in real-national income associated with not exploiting domestic offshore resources is quite sizable. Having a large reserve of stored oil would give the US a better bargaining position in the international markets. The author proposes that compensation plans for the locations where offshore oil production takes place and which would be environmentally disbenefitted could be worked out. (DCM)

Nuclear offshore storage for liquid hydrocarbons. J. Despois, Y. Pralong (CEA, Paris, France), F. Nougarede, J.P. Sarda. *Trans. Am. Nucl. Soc. (USA)*, vol. 17, p. 26 (Sept. 1973). (American Nuclear Society 1973 Winter Meeting (summary), San Francisco, Calif., USA, 11-15 Nov. 1973).
 The economics of storing crude oil offshore in cavities created by nuclear explosions are discussed (no refs.)

N73-16948# Delaware Bay Oil Transport Committee. Dover. ENERGY, OIL, AND THE STATE OF DELAWARE. A PROPOSAL FOR SAFEGUARDING THE DELAWARE ESTUARY AND COASTLINE BY SAFER TRANSPORT OF OIL
 15 Jan. 1973 61 p refs
 Avail: NTIS HC \$5.25
 The pollution hazards of petroleum industries and shipping in the Delaware Bay are considered. Petroleum refineries on the Delaware River, Delaware River traffic, lightering operations in the lower bay, cleanup responsibility of spilled oil, oil imports, and world crude oil transportation are discussed along with alternative petroleum transport systems. Recommendations for the increased protection from spills are included. F.O.S.

N73-18981*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio. AIR-CUSHION TANKERS FOR ALASKAN NORTH SLOPE OIL
 John L. Anderson Washington Mar. 1973 30 p refs
 (NASA-TM-X-2683; E-7210) Avail: NTIS HC \$3.00 CSCL OIC
 A concept is described for transporting oil from the Arctic to southern markets in 10,000-ton, chemically fueled air-cushion vehicles (ACVs) configured as tankers. Based on preliminary cost estimates the conceptual ACV tanker system as tailored to the transportation of Alaskan North Slope oil could deliver the oil for about the same price per barrel as the proposed trans-Alaska pipeline with only one-third of the capital investment. The report includes the description of the conceptual system and its operation; preliminary cost estimates; an appraisal of ACV tanker development; and a comparison of system costs, versatility, vulnerability, and ecological effect with those of the trans-Alaska pipeline.

N74-16675# RAND Corp., Santa Monica, Calif. THE SOVIET UNION, THE MIDDLE EAST, AND THE EVOLVING WORLD ENERGY SITUATION
 Arnold L. Horelick Oct. 1973 10 p ref Presented at Conf. on Choices for Europe and Am. The Middle East and the Energy Situation, 1973-1985, Ditchley Park, Engl.; sponsored by Ditchley Found., Intern. Inst. for Strategic Studies, Middle East Inst., and the World Peace Found.
 (P-5109) Avail: NTIS HC \$3.00
 The U.S.S.R.'s position on the world oil crisis is discussed with special attention given to the limits of Soviet influence in global politics and a Soviet-preferred future world energy scenario. K.M.M.

1973

TITLE: Oil Production to Expect from Known Technology

AUTHOR: Gaffen T.P.

CORPORATE AUTHOR: Asoco Production Co.

ADDRESS: Tulsa, OK

PUBLICATION DESCRIPTION: The Oil and Gas Journal, 66-76; Paper presented at third annual meeting, API Division of Production, Denver, April 9-11, 1973, under the original title, "Improved Oil Recovery Expectations when Applying Available Technology."

PUBLICATION DATE: 1971, May 7

ABSTRACT: Because of the current oil shortage, tertiary oil recovery methods should be advanced as quickly as possible. These methods should add \$0.75 to \$1.50 to the cost of a barrel. Much technology has already been developed, future breakthroughs will be economical. A description of various tertiary methods is given, with advantages and disadvantages of each. (JMC)

OIL: THE OMNIPOTENT ENERGY SOURCE. Griedlander, G. D. IEEE (Inst. Elec. Electron. Eng.), Spectrum, 10: No. 7, 26-29 (Jul 1973).

Between 1973 and 1985, an adequate petroleum supply will be the hinge or fate for the US economy. In reviewing a brief history of the oil exports of the Arab states in the last few years, it is seen that the US must develop new oil sources, construct refineries within its continental borders, and establish conservation policies that will mitigate the coming crunch. The dependency of countries on the oil exports from the Middle East may be used as a weapon or club, as has been observed in Italy. In the US, since oil will be the predominant energy fuel during the next 12 years (the only fuel capable of meeting our escalating energy requirements), the potentially adverse effects of Middle East manipulation of the oil flow on the balance-of-payments deficit are staggering. A National Petroleum Council summary lists three options; the US could depend upon increased overseas import of oil and gas to meet national requirements but this would impair national security and trigger an awesome deficit in our balance of trade in fuels; through imposed restrictions, the US could reduce the growth in energy consumption and demand more efficient use of energy, impairing the nation's lifestyle and triggering an even larger deficit in its balance of trade in fuels; the US can accelerate the development of its domestic energy resources and this is strongly recommended. (MCW)

N74-18194# RAND Corp. Santa Monica Calif
PETROLEUM: A PREDICTION MADE IN 1950
James H. Hayes Dec. 1973 11 p refs
(P-5135) Avail: NTIS HC \$4.00 CSCL 11H

An outline of the world petroleum situation as it relates to the United States is presented. The various geographical areas where petroleum is found are examined with emphasis on the longevity of the sources as well as how political situations affect the accessibility of the sources. The need for replacing inaccessible sources by alternate sources and synthetic processes is examined. S.K.W.

1973

TITLE: Emergency Preparedness for Interruption of Petroleum Imports into the United States - A Supplemental Interim Report of the National Petroleum Council

AUTHOR: Bennett, C.N. (Chairman)

CORPORATE AUTHOR: National Petroleum Council, Committee on Emergency Preparedness

ADDRESS: 1625 K Street NW, Washington, DC 20006

PUBLICATION DESCRIPTION: 60 p. Report reprinted in Congressional Committee Print Serial No. 93-26 (2-61), "Estimates and Analysis of Fuel Supply Outlook for 1978", p. 65

PUBLICATION DATE: 1973, November 15

ABSTRACT: The findings and recommendations of the National Petroleum Council relating to the current interruption of petroleum imports are reported. Emergency actions to increase domestic supplies include: marine production from Naval Petroleum Reserves at Elk Hills, CA; incremental gas sales to industries now burning fuel oil or distillates; accelerate licensing of already constructed nuclear power plants; and increase use of coal. Energy use must be reduced, since there will still be a net shortage of oil after the emergency actions to increase supplies are taken. Voluntary conservation measures will account for about 50% of the net shortage. Mandatory rationing is therefore necessary and should be instituted immediately. (HPC)

1973

N74-16891# Army War Coll. Carlisle Barracks, Pa
UNITED STATES PETROLEUM SITUATION THROUGH 1980
Robert W. Huebner 14 Mar. 1973 54 p refs
(AD-761576) Avail: NTIS CSCL 10/2

The current and projected United States petroleum and natural gas requirements through 1980 are examined. These two resources account for three-fourths of all the energy consumed in the United States. The unprecedented rate at which they are being consumed has caused an imbalance between demand and supply and presents the Nation with an energy problem of serious and growing proportions. Domestic production is now unable to supply the needs of some consumer sectors and shortages of certain fuels exist. During the next three to five years, a further deterioration of the domestic supply position is anticipated and a sharp increase in imports is projected. The long lead times required to provide new domestic supplies make this development virtually certain. The United States also faces a serious balance of trade deficit as a result of our growing need for imports. In short, our petroleum position will become more severe in the longer term if present trends and policies continue. Author (GRA)

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A Review of the Present, and Announced Future, Capabilities for Commercial Oil Recovery Beyond the 656-Foot Isobath.
L. C. Leopold.

State Univ. of New York, Stony Brook. Marine Sciences Research Center. 1973. 8p NOAA-74020701-6 Included in Marine Affairs Jnl., n1 p91-97, Dec 73.
COM-74-10584-06/WN (Order as COM-74-10584)

This is a brief look at the commitment of the oil industry to deep, offshore exploitation. It is assumed that a significant way to gauge its expectations of deep, greater than 656 feet, recovery is to look at the actual capabilities and the expansion of attendant technologies. There are two portions to this paper. The first is a tabulation inventory of drilling rigs. The inventories for 1969, 1970, 1971, and 1972 are presented in tables 1, 2, 3, and 4, respectively. The second part of the paper is a synthesis of specific reports. Each helps to define what the developed capabilities for, and commitments to, commercial oil recovery at depths greater than 656 feet are.

WORLD ENERGY MODELLING: THE DEVELOPMENT

OF WESTERN EUROPEAN OIL PRICES. Deam, R. J.; Loughton, M. A.; Hale, J. G.; Isaac, J. R.; Leather, J.; O'Carroll, F. M.; Ward, P. C. (Queen Mary Coll., London). Energy Policy; 1: No. 1, 21-34(Jun 1973).

A computer model is being constructed to cover the whole international energy industry. Results confirm that the concepts and assumptions being used in building the World Energy Model are applicable to the real world. The short-term behavior of oil product prices in Europe over the past six years has been consistent with the hypothesis of free competition acting on the kind of marginal cost structure assumed in the model. Long-term average relationships between oil product prices agree with the implications of a simplified version of the model's representation of refining economics. Work now in progress is steadily improving the breadth of coverage and degree of detail of the results that can be obtained. (DLC)

OFFSHORE DEEPWATER CRUDE-OIL TERMINALS.

Masrenik, J. (Esso Research and Engineering Co., Linden, NJ). Combustion; 45: No. 4, 7-14(Oct 1973).

Offshore deepwater crude-oil terminals appear to have favorable economic-benefit/cost ratios, and would possibly have the least effect on the ecology of a region. Single-point mooring (SPM) has been found particularly attractive for mooring very large crude carriers (VLCC) in moderate to severe sea and wind conditions. A new cluster concept is outlined along with the oil industry's effort to make SPM more reliable. Multibuooy moorings (NBM) are used at marketing, refining, and crude-loading terminals throughout the world at crude-loading and receiving terminals, especially since the advent of the VLCC. Single-point moorings are very common for mooring VLCCs. The types in use are the catenary anchor-leg mooring (CALM), the single anchor-leg mooring (SALM), SPM tower with rotating trussed arm (Brega, Libya), and SPM tower with floating hose (Fiumicino and Genoa, Italy). (MCW)

TITLE: The Realities and Unrealities of Energy Economics

AUTHOR: Morrison, R.
PUBLICATION DESCRIPTION: Sterra Club Bulletin, May 1973, 4 p.
PUBLICATION DATE: 1973

ABSTRACT: In a humorous style, the total complex of the petroleum marketing system in this country is described. The system is manipulated by the large oil companies to take advantages of huge government subsidies and tax benefits. Electric utilities behave somewhat similarly. (JRC)
AVAILABILITY: Sterra Club, 1050 Mills Tower, San Francisco, CA 94108

1971 Petroleum Supply and Demand in the Non-Communist World.

Office of Oil and Gas, Washington, D.C. Mar 73. 37p
PB-227 793/7WN PC\$5.00/MF\$1.45

This booklet contains a summary of 1971 petroleum data collected from many sources, analyzed by the Economics and Coordination group of Programs and Analysis Division of the U.S. Office of Oil and Gas, and compiled in ready-reference handbook form. It is believed that this summary presents as realistic a portrayal of 1971 Non-Communist World petroleum supply and demand as can be obtained.

**N74-16697# Army War Coll., Carlisle Barracks, Pa.
THE US ENERGY CRISIS. THE MULTINATIONAL OIL CORPORATIONS AND THEIR RELATIONSHIP TO U.S. FOREIGN POLICY IN THE MIDDLE EAST**

John G. Pappageorge 28 Feb. 1973 59 p refs
(AD-760868) Avail: NTIS CSCL 05/3

America's current energy crisis consists of a growing dependence on foreign oil brought about by a continuing diminution in known domestic petroleum reserves and aggravated by a host of domestic anomalies that cry out for some sort of unified energy policy. Yet any steps taken domestically will have far reaching international effects, particularly in the Middle East. Eight giant corporations (five of them American) discover and pump most of the oil out of the ground in the producing countries. Hence, they have a powerful influence in the Middle East and are a contributing factor in the stability of that politically volatile part of the world. Modified author abstract (GRA)

(WASH-1281-3) FUEL TRANSPORTATION, DISTRIBUTION, AND STORAGE. Subpanel Report III Used in Preparing the AEC Chairman's Report to the President. See-inger, J. H. (USAEC, Washington, D. C.). 13 Nov 1973. 163p. Dep. NTIS \$11.25.

On October 27, 1973, this subpanel recommended R and D funded at a 5-year level of \$152.4 million in four subprogram categories: (1) pipelines, (2) ocean delivery systems, (3) large nuclear underground, and (4) hydrogen TDS. The Overview Panel's screening reduced these recommendations to one subprogram (Ship Delivery Systems) at a 5-year funding level of \$50 million. Based on this funding, the expected achievements during the next five fiscal years are: (1) detailed design of Arctic surface tankers suitable for transporting oil from certain regions of the Arctic to U. S. East Coast ports safely and economically; (2) detailed design and advanced components for Arctic submarine tankers for use where pipelines and surface tankers are not feasible; (3) detailed design of Arctic marine terminals, both surface and submerged, followed by feasibility demonstration; and (4) acceptance, commitment, and participation in these programs by commercial operators on the basis of established technology and economic desirability. (LMT)

DEEPWATER PORTS: ISSUE MIXES SUPERTANKERS, LAND POLICY. Science, 181: No. 4192, 826-827(31 Aug 1973).

The USA will be relying heavily on foreign oil at least through the 1980's, even if a policy of energy conservation is adopted such as discouraging the use of heavy, high-gas consumption automobiles. The cost of providing existing ports with facilities to accommodate the supertankers is examined. Since this appears to be prohibitive, both economically and environmentally, the deepwater terminals are discussed. There are varying concepts of deepwater terminals, ranging from the building of an artificial island and breakwater to the simple concept of the single point mooring (SPM). A deepwater terminal of the SPM type can offer environmental as well as economic advantages over alternative systems for the delivery of imported oil. The problems peculiar to the supertanker and the "landside" problems associated with large-scale delivery of oil by supertankers and offshore terminals are indicated. (MCW)

The future availability of oil. H. R. Warman. Conference on World Energy Supplies, London, England, 18-20 Sept. 1973 (London, England: Financial Times, 1973). 11pp. Examines the evidence concerning the future availability of oil. Both conventional crude oil and 'non-conventional' oil are considered but the emphasis is on conventional crude oil. (no refs.)

MANDATORY OIL IMPORT QUOTA PROGRAM: A CONSIDERATION OF ECONOMIC EFFICIENCY AND EQUITY. Cicchetti, C. J. (Univ. of Wisconsin, Madison); Gillen, W. J. Nat. Res. J.; 13: No. 3, 399-430(Jul 1973).

The historical development of the Mandatory Oil Import Quota Program is reviewed, and the manner in which it functions is described. Several analyses made during and shortly after the Cabinet Task Force Report are reviewed, and these are updated to reflect changing market conditions. Finally, the equity and efficiency aspects of the program are analyzed in the context of its objectives, and alternative means of achieving those objectives are considered. (MCW)

MANAGEMENT AND ECONOMICS IN THE OIL INDUSTRY: A REVIEW. Glenn, W. E. J. Petrol. Technol.; 25: 1342-1346(Nov 1973).

In the late 20th century and up until the 1930's, the new uses for petroleum kept supply vs demand or consumption essentially balanced. The balance was destroyed when oil was discovered in East Texas, and the increased supply gave birth to a new technological era. Conservation or the prevention of physical and economic waste was a prelude to understanding reservoir mechanics and to the great push to optimize production economics. Conservation, well logging, secondary recovery including waterflooding and pressure maintenance by water or gas injection, numerical analyses of such parameters as costs or offshore risks, drilling and completions, automation, offshore drilling, and economics are discussed. (MCW)

CM-129, 601, Nos. 580 & 579 (1973)
MEN AND MOLECULES. SIDE I: THE OIL MYSTERY.
Harold Bernard. (Radio series 580). SIDE II:
THE LANGUAGE OF OILS. Stanley Freeman. (Radio
Series 579). (1973). (Audiotape).

- American Chemical Society
- American Chemical Society
- American Chemical Society
- Radio Series 580
- Radio Series 579

Petroleum
Water pollution - Oil

(Ordered for E.E. Mason
May '73 - No order number).
L-5-28-73 L-9, 175

1973

TITLE: Capital Needs Join Supply as Major Industry Concern
CORPORATE AUTHOR: World Oil, Gulf Publishing Co.
ADDRESS: Box 2608, Houston, TX 77001
PUBLICATION DESCRIPTION: World Oil, 177, 63-66
PUBLICATION DATE: 1973, August
ABSTRACT: A major problem in the petroleum industry is beginning to be sufficient capital to finance additional exploration. An increase in prices is a solution. Detailed tables are given for 1971, 1972, and estimated 1973 of world petroleum demand and supply, world crude oil production and producing wells, forecast of world drilling in 1973, and estimated proved world reserves of crude oil and natural gas. (JMC)

(COM-73-11353-2) OFFSHORE DRILLING: A BIBLIOGRAPHY WITH ABSTRACTS. Report for 1964-May 1973. Lehmann, E. J. (National Technical Information Service, Springfield, Va. (USA)). Jul 1973. 29p. (NTIS-WIN-73-9). NTIS \$20.00.

The NTISearch bibliography contains 25 selected abstracts of research reports retrieved using the NTIS on-line search system - NTISearch. The abstracts are primarily concerned with the environmental effects from offshore drilling. (GRA)

N73-30464* Massachusetts Inst. of Tech., Cambridge.
SOME PROBLEMS AND PROSPECTS FOR MARINE TRANSPORTATION OF OIL IN THE 1970S
Zenon S. Zannetos Mar. 1973 21 p refs Presented at the Energy: Demand, Conserv. and Institutional Probl. Conf., Cambridge, Mass., 12-14 Feb. 1973
(Grant NGL-22-009-309)
(NASA-CR-133854; Rept-649-73) Avail: NTIS HC\$3.25 CSCL 05C

The problems associated with, and the financial resources required for ocean transportation of petroleum in the 1970s are discussed in terms of the energy crisis. Spot rate fluctuations for tankers are examined along with the financial requirements for ocean transportation. F.O.S.

UNITED STATES OIL IMPORTS: IMPLICATIONS FOR THE BALANCE OF PAYMENTS. Frank, H. J.; Well, D. A. (Univ. of Arizona, Tucson). Nat. Res. J.; 13: No. 3, 431-447 (Jul 1973).

The background of the energy shortage, projections of future import requirements by 1980, estimation of the cost of these imports, examination of their probable impact on the U. S. international payments position, and the balance of payments adjustment mechanisms designed to cope with this impact are discussed. The development of domestic energy sources at higher cost will have balance of payments repercussions reflected in the overall cost structure of U. S. industry. (MCW)

ENERGY REPORT/OIL IMPORT NEEDS VERSUS ENVIRONMENTAL COSTS KEY ISSUE IN DEEP WATER PORTS LEGISLATION.

J. A. Noone.

National Journal Reports, v.5, no.45, Nov.10,1973, 1665-1675.

THE US SUPERPORT CONTROVERSY.

H.S. Marcus.

Technology Review, v.75, no.5, Mar/Apr.1973, p.49-57.

The trend to ever larger vessels is inexorable. National interest argues powerfully for building facilities to accommodate the largest of them.

1973

TITLE: The Georges Bank Petroleum Study - Volume I: Impacts on New England Real Income of Hypothetical Regional Petroleum Developments
CORPORATE AUTHOR: Massachusetts Institute of Technology, Offshore Oil Task Group
ADDRESS: Cambridge, MA 02139
PUBLICATION DESCRIPTION: Report No. MITSG 73-5, 284 p.

PUBLICATION DATE: 1973, February 1
SPONSOR: U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Sea Grant Program; New England River Basins Commission; New England Regional Commission; National Science Foundation, RANN Program
ABSTRACT: This is Volume I of a three part report studying the implications of a petroleum development on the New England continental shelf. The impact on regional income is treated in this volume, but the authors advise reading both volumes as certain conclusions drawn in one volume depend upon results developed in the other. Chapter one gives an introduction to regional income analysis and defines the scope of the study and some particular implications that are not covered. Other chapter titles are Simulation of Petroleum Development Hypotheses; The Response of Regional Products Prices to Changes in Cost; Treatment of Private and Public Profits; The Impact on Regional Income of Employment Effects Associated with the Hypothetical Developments; Impact on Regional Income of the Georges Bank Fishery - Georges Bank Petroleum Conflict; Regional Income Impact of Nearshore Spills; and Results of Simulations. (DCH)

TITLE: The Georges Bank Petroleum Study - Volume II: Impact on New England Environmental Quality of Hypothetical Regional Petroleum Developments
CORPORATE AUTHOR: Massachusetts Institute of Technology, Offshore Oil Task Group
ADDRESS: Cambridge, MA 02139
PUBLICATION DESCRIPTION: Report No. MITSG 73-5, 311 p.

PUBLICATION DATE: 1973, February 1
SPONSOR: U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Sea Grant Program; New England River Basins Commission; New England Regional Commission; National Science Foundation, RANN Program
ABSTRACT: This is the second volume of a three volume study of the impact on New England of a range of possible changes in the region's petroleum production, crude processing and products distribution system including a spectrum of hypothetical petroleum discoveries on the Georges Bank. Volume II concentrates on the impact on regional environmental quality. The authors emphasize that neither volume I nor volume II can be read independently of the other and is particular much of the analysis of volume II depends on the results of Chapters 1 and 6 of volume I. (Author, Foreword modified)

1972

N74-16656 Texas Univ., Austin. College of Social and Behavioral Sciences.

BALANCING THE DEMAND AND SUPPLY OF OIL

James W. McKie / In Denver Univ. Balancing Supply and Demand for Energy in the US 1972 p 73-90 refs (For availability see N74-16651 07-34)

The economic factors which influence the supply and demand of crude oil in the U.S. are discussed. Estimates are made of the projected availability of petroleum from domestic sources through the year 1980. The availability of petroleum supplies based on the predictions of exploration and development is analyzed. Tables of data are provided to show the following: (1) projections of the oil supply-demand balance from 1980 to 1985, and (2) estimates of domestic U.S. production in 1975, 1980, and 1985. The need for a Federal energy policy is stressed and approaches to such a policy are submitted. Author

N74-16661 Texas Univ., Austin.
ENVIRONMENTAL PROTECTION AND LONG RUN SUPPLY OF CRUDE OIL IN THE UNITED STATES

Stephen L. McDonald / In Denver Univ. Balancing Supply and Demand for Energy in the US 1972 p 145-158 refs (For availability see N74-16651 07-34)

A study was conducted to determine the effects of energy conversion on the environment. The effects of various types of energy sources were examined and examples of legislation to reduce environmental pollution are presented.

1972

TITLE: Oil Prices and Phase II
CORPORATE AUTHOR: U.S. Congress, Joint Economic Committee

PUBLICATION DESCRIPTION: Hearings before the Subcommittee on Priorities and Economy in Government of the Joint Economic Committee, Congress of the U.S., 92nd Congress, First Session, 349 p.

PUBLICATION DATE: 1972, January
ABSTRACT: While the consumer costs of Federal oil policy have grown and grown, there is serious question whether Federal policies are at all effective in meeting their prime objective of providing secure and readily available domestic sources of energy for our future use. The importance of wise development and conservation of our energy resources as well as the necessity of fighting inflation make it urgent that we reexamine Federal oil policies. These hearings have been called with the hope of identifying those possibilities for policy change which would contribute most to an effective anti-inflation effort consistent with encouraging the development of our energy resources. (FROM INTRODUCTION BY SEN. V. PROxmire)

1972

N74-16655 Massachusetts Inst. of Tech., Cambridge. Dept. of Economics.

LONG RUN COST TRENDS: PERSIAN GULF AND UNITED STATES

M. A. Adelman / In Denver Univ. Balancing Supply and Demand for Energy in the US 1972 p 39-72 refs (For availability see N74-16651 07-34)

The production costs of crude oil and natural gas in the U.S. are compared with those for the Persian Gulf nations. A theory of petroleum production costs is presented to show the relationship between production, development, and exploration of petroleum supplies. The effect of changing sources of reserves on the development costs of new petroleum resources is analyzed. The expected supply from the North Shore Alaska petroleum field is reported. Tables of data are included to show the following: (1) development investment in Persian Gulf petroleum, (2) cost projection of Persian Gulf resources from 1965 to 1969, (3) exploration activity and expenditures in North American petroleum development from 1955 to 1970, and (4) significant discoveries of oil and gas from 1945 to 1964. Author

N74-19228 Environmental Protection Agency, Research Triangle Park, N.C. Air Pollution Technical Information Center.
AIR POLLUTION ASPECTS OF EMISSION SOURCES: PETROLEUM REFINERIES: A BIBLIOGRAPHY WITH ABSTRACTS

Jul. 1972 73 p refs

(AP-110) Avail: SOD HC \$1.25

Selected abstracts are presented of articles concerning air pollution by petroleum refineries. Subject and author indexes are included. Author

(HIT-499) **STUDY OF THE FUTURE SUPPLY OF LOW SULFUR OIL FOR ELECTRICAL UTILITIES.** (Hittman Associates, Inc., Columbia, Md. (USA)). Feb 1972. 76p. (PB-209-257).

The factors influencing the supply and demand of low-sulfur residual oil were studied. The demand for residual oil by all domestic markets including the utilities will increase from 2.25 million bbl/day in 1970 to 3.90 million bbl/day in 1980. Electrical utilities' share of the total demand will increase significantly in the 1970s from 0.64 million bbl/day to 2.24 million bbl/day. About 3.20 million bbl/day or 83 percent of the total demand for residual oil will be under Federal or local regulations by the year 1980.

Total residual supply is estimated to equal demand with only a minor increase in imports over the current import trend line. Low-sulfur residual, however, will not meet regulated demand without an intense effort beyond reasonable expectations. A large percentage of South American residual must be desulfurized. Significant domestic residual desulfurization will also be necessary. (auth)

CK-129,355,v.1a2 1972
U.S. DEEPWATER PORT STUDY. VOLUME I: SUMMARY AND CONCLUSIONS. VOLUME II: COMMODITY STUDIES AND PROJECTIONS. Ralph L. Trisko, Philip Cheney, Jacobus de Rover, et al. (Final rept.). Aug.1972. 74p; 603p.

Nathan (Robert R.) Associates, Inc.
Army Corps of Engineers IWR Rept.72-8,
Inst. for Water Resources v.1 & 2
Defense Documentation Center AD 750 090
Defense Documentation Center AD 750 091
Contract DACW31-71-C-0045
Ports, Deepwater Ecology
Economics Petroleum Industry 188,869

CK-129,355,v.3 1972
U.S. DEEPWATER PORT STUDY. VOLUME III: PHYSICAL COAST AND PORT CHARACTERISTICS, AND SELECTED DEEPWATER PORT ALTERNATIVES. Ralph L. Trisko, Philip Cheney, Jacobus de Rover, et al. (Final rept.). Aug.1972. 542p. & illus.

Nathan (Robert R.) Associates, Inc.
Army Corps of Engineers IWR Rept.72-8,
Inst. for Water Resources v.3
Defense Documentation Center AD 750 092
Contract DACW31-71-C-0045

Ports, Deepwater
Economics
Ecology
L-4-12-73

CK-129,355,v.4 1972
U.S. DEEPWATER PORT STUDY. VOLUME IV: THE ENVIRONMENTAL AND ECOLOGICAL ASPECTS OF DEEPWATER PORTS. Ralph L. Trisko, Philip Cheney, Jacobus de Rover, et al. (Final rept.). Aug. 1972. 298p.

Nathan (Robert R.) Associates, Inc.
Army Corps of Engineers IWR Rept.72-8,
Inst. for Water Resources v.4
Defense Documentation Center AD 750 093
Contract DACW31-71-C-0045

Ports, Deepwater
Environment
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L-3-21-73

CK-129,355,v.5 1972
U.S. DEEPWATER PORT STUDY. VOLUME V: TRANSPORT AND BENEFIT-COST RELATIONSHIPS. Ralph L. Trisko, Philip Cheney, Jacobus de Rover, et al. (Final rept.). Aug.1972. 563p.

Nathan (Robert R.) Associates, Inc.
Army Corps of Engineers IWR Rept.72-8,
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Defense Documentation Center AD 750 094
Contract DACW 31-71-C-0045

Ports, Deepwater
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Ecology
L-88,869
L-4-12-73

CN-129, 425, v.1
1972
OFFSHORE TERMINAL SYSTEM CONCEPTS. PART 1:
EVALUATION OF REQUIREMENTS AND CAPABILITIES FOR
DETERMINATION OF THE NEED FOR OFFSHORE TERMINALS.
(A Report submitted to the Dept. of Commerce).
Sept. 1972.

Soros Associates, Inc.
Department of Commerce
Contract 1-35409

Ports, Deepwater
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Petroleum

L-88867
L-4-11-73

CN-129, 425, v.3
1972
OFFSHORE TERMINAL SYSTEM CONCEPTS. PART 3:
FORMULATION OF ADVANCED CONCEPTS FOR OFFSHORE
TERMINALS. (A report submitted to the Dept. of
Commerce). Sept. 1972.

Soros Associates, Inc.
Department of Commerce
Contract 1-35409

Ports, Deepwater
Ports, Offshore
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L-88867
L-4-11-73

CN-129, 425, v.2
1972
OFFSHORE TERMINAL SYSTEM CONCEPTS. PART 2:
CONNECTIONS BETWEEN DEEP-DRAFT TERMINALS AND
EXISTING FACILITIES BY UTILIZATION OF FEEDER
VESSELS, PIPELINES AND/OR SHORE FACILITIES
RELOCATION. (A report submitted to the Dept. of
Commerce). Sept. 1972.

Soros Associates, Inc.
Department of Commerce
Contract 1-35409

Ports, Deepwater
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CN-129, 425, v.4
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EXECUTIVE SUMMARY. (A report submitted to the
Dept. of Commerce). Sept. 1972.

Soros Associates, Inc.
Soros Associates, Inc.
Department of Commerce
Contract 1-35409

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Ports, Offshore
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MA-RD-730001

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1972
 CN-129, 427, v. 4
 ENVIRONMENTAL IMPACT STATEMENT (-) PROPOSED
 TRANS-ALASKA PIPELINE - FINAL. VOLUME 4:
 EVALUATION OF ENVIRONMENTAL IMPACT. (Prepared
 by a Special Interagency Task Force for the
 Federal Task Force on Alaskan Oil Development).
 1972. 537p. & charts.

Department of the Interior
 Interagency Task Force for the
 Federal Task Force on Alaskan Oil Development
 (Council on Environmental Quality)

Trans-Alaska Pipeline
 Environment
 Pollution
 L-4-11-73

1972
 CN-127, 427, v. 6
 ENVIRONMENTAL IMPACT STATEMENT (-) PROPOSED
 TRANS-ALASKA PIPELINE - FINAL. VOLUME 6:
 CONSULTATION AND COORDINATION WITH OTHERS, DIS-
 CUSION OF POINTS RAISED DURING REVIEW AND THE
 PUBLIC HEARING PROCESS. ATTACHMENTS. (Prepared
 by a Special Interagency Task Force for the
 Federal Task Force on Alaskan Oil Development).
 1972. 102p. & attc.

Department of the Interior
 Interagency Task Force for the
 Federal Task Force on Alaskan Oil Development
 (Council on Environmental Quality)

Trans-Alaska Pipeline
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 L-4-11-73

1972
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 ENVIRONMENTAL IMPACT STATEMENT (-) PROPOSED
 TRANS-ALASKA PIPELINE - FINAL. VOLUME 1: INTRO-
 Duction AND SUMMARY. (Prepared by a Special
 Interagency Task Force for the Federal Task
 Force on Alaskan Oil Development). 1972. 322p. &
 app.

Department of the Interior
 Interagency Task Force for the
 Federal Task Force on Alaskan Oil Development
 (Council on Environmental Quality)

Trans-Alaska Pipeline
 Environment
 Pollution
 L-3-11-73

1972
 CN-129, 427, v. 3
 ENVIRONMENTAL IMPACT STATEMENT (-) PROPOSED
 TRANS-ALASKA PIPELINE - FINAL. VOLUME 3: ENVIRON-
 MENTAL SETTING BETWEEN PORT VALDEZ, ALASKA, AND
 WEST COAST PORTS. (Prepared by a Special Interagency
 Task Force on Alaskan Oil Development). 1972. 374p.

Department of the Interior
 Interagency Task Force for the
 Federal Task Force on Alaskan Oil Development
 (Council on Environmental Quality)

Trans-Alaska Pipeline
 Environment
 Ecology
 Oils, Petroleum
 L-9-6-73

2157

Ports, Deepwater
Oils, Petroleum

LRC 73-59
L-4-2-73

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CAPABILITY OF THE NAVAL PETROLEUM AND ♦ ♦ ♦ ♦ ♦ OIL ♦ ♦ ♦ ♦ ♦ NEEDS; REPORT TO THE
RESERVES TO MEET EMERGENCY ♦ ♦ ♦ ♦ ♦ OIL ♦ ♦ ♦ ♦ ♦ NEEDS; REPORT TO THE
CONGRESS (ON THE) DEPARTMENT OF THE NAVY (AND THE) DEPARTMENT OF THE
INTERIOR BY THE COMPTROLLER GENERAL OF THE UNITED STATES.
UNITED STATES. GENERAL ACCOUNTING OFFICE.

WASHINGTON; 58 P. ILLUS. 27 CM.
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72N72752 BMRI-7500 71/04/00 15 PAGES UNCLASSIFIED DOCUMENT
PREDICTION OF OIL- AND GAS-BEARING ROCK FRACTURES FROM SURFACE
STRUCTURAL FEATURES
A/QVERBEY, W. K., JR.; B/ROUGH, R. L.
BUREAU OF MINES, WASHINGTON, D.C.
/♦CRUDE OIL/♦GEOLOGY/♦NATURAL GAS/♦SURFACE PROPERTIES/ EARTH
RESOURCES/ FRACTURES (MATERIALS)/ PREDICTIONS

CN-140,115, Rept. 2
(1972)
LOUISIANA SUPERPORT STUDIES. REPT NO.2: PRELIMINARY
ASSESSMENT OF THE ENVIRONMENTAL IMPACT OF A
SUPERPORT ON THE SOUTHEASTERN COASTAL AREA OF
LOUISIANA. James H. Stone. (1972). 345p.

LSU-80-72-05

Louisiana State U.
Center for Wetland Resources

NOAA Sea Grant 2-35231

Ports, Deep water

Environment

Water pollution - Oil

Oceanography

Louisiana

Sea Grant Program

L-11-15-73

TITLE: United States Petroleum Through 1990
CORPORATE AUTHOR: Citicorp Services Co.
ADDRESS: Suite 207, 1660 L St. NW., Washington,
D.C. 20036

PUBLICATION DESCRIPTION: 87 p.

PUBLICATION DATE: 1971, June

ABSTRACT: This report is a study consisting of
several papers describing the production,
supply, and demand of petroleum and natural
gas through 1990. It is geographically
concerned primarily with the United States,
but Canadian, Latin American, and Free
Eastern Hemisphere supply-demand summaries
are included. There are numerous charts,
graphs, and tables illustrating facts brought
out in the text. (DCH)

CN-140,115, Rept. 1
1972
LOUISIANA SUPERPORT STUDIES. REPORT NO.1: PRE-
LIMINARY RECOMMENDATIONS AND DATA ANALYSIS. (Period
covered: Jan.1-June 15,1972). Aug.1972. 419p.

LSU-80-72-03

Louisiana State U.
Center for Wetland Resources

NOAA Sea Grant 2-35231

Ports, Deep water

Louisiana

Sea Grant Program

L-11-15-73

TITLE: Deep Water Port Policy Issues
CORPORATE AUTHOR: U.S. Senate, Committee on
Interior and Insular Affairs
PUBLICATION DESCRIPTION: Committee print Serial
No. 92-26. Hearing pursuant to S. Res. 85, 1
National Fuels and Energy Policy Study, 92nd
Congress, 2nd Session, on Current Federal
Programs and Plans for the Formulation of a
National Policy for Deep Water Port
Development in the U.S., April 25, 1972: 68p.

PUBLICATION DATE: 1972

ABSTRACT: This is an open hearing before the full
Committee on Interior and Insular Affairs,
and is part of the committee's national fuels
and energy policy study being conducted under
the authority of Senate Resolution 85. The
purpose of this hearing is to examine the
prospective benefits and risks of deep water
port developments in the United States.
---The hearing this morning provides an
excellent opportunity to investigate the
entire issue of deep water port development
as it relates to our national fuels and
energy policy. From these proceedings we
hope to ascertain what the current policies
of Federal agencies are toward deep water
port development and what the elements of an
overall national policy ought to be.
Particular attention will be given to the
role the Federal Government should play in
the selection and development of deep water
facilities and whether it should take on new
responsibilities for centralized planning and
policy development. (from opening statement
by Sen. M. Gravel)

CN-140,460
1971
PETROLEUM FACTS AND FIGURES. (Incorporates all the
data in the 1959 Centennial edition and subsequent
supplemental editions, together with latest
information available). May 1971. 604p.

American Petroleum Inst.

Handbooks - Petroleum

Handbooks - Amer. Petroleum Inst.

Petroleum Industry

Fuel - Consumption

Petroleum

Gasoline

Gases, Natural
Fuels, Oil

L-4-3-74 LRC 74-23

Technology Review, v.76, no.6, May 1974, p.35-

The Supply of Natural Gas

ENERGY REPORT/CONGRESS NEARS SHOWDOWN ON PROPOSAL TO DECONTROL GAS PRICES.

James, G. Phillips.

National Jour. Reports, 5/25/74, p.761-775.

The attempt to end federal regulation of natural gas prices seems destined to fail again this year despite the increased impetus provided by the energy shortage. But because Congress is divided more evenly on this issue than on many others, the battle over deregulation promises to continue for the rest of the session. At the heart of the dispute is the contention by producers that existing rates don't provide enough profit for them to develop more sources of natural gas. Consumer groups insist producers are simply leaving their gas in the ground in expectation of higher prices.

The shortage of natural gas in the United States has grown rapidly in the last two or three years. By now, it probably exceeds ten per cent of total demands. This is not a result of a shifting of demands to natural gas due to the Arab oil embargo. Rather, it is a continuous and systematic long-term shortage, and there is every reason to believe that it will not be eased appreciably in the remaining years of this decade under the prevailing Federal Power Commission price controls—even if the F.P.C. were to continue its recent policies of raising the price an average of three or four cents per thousand cubic feet on new contracts each year. If great pressure is put upon gas demands as a result of oil price increases beyond \$8.00 per barrel, excess demand is likely to expand to more than a quarter of total demand in the next few years.

74V12439 1974 ISS:00 TP761.L3L65 0-470543-84-1 665.773 LC-74-1459

A/LDM; WALTER LOWENSTEIN.

LIQUEFIED ♦♦ NATURAL ♦♦ ♦♦ GAS ♦♦ (BY) W. L. LDM.

WILEY NEW YORK;

"A HALSTED PRESS BOOK." INCLUDES BIBLIOGRAPHIES.

LC:LIQUEFIED ♦♦ NATURAL ♦♦ ♦♦ GAS. ♦♦

MAIN-AUTH TRACE-TITL♦ CATLG BY-LC

Cryogenics & Industrial Gases, v.9, no.1, Jan/Feb.74.

Automotive LNG: Hydrogen's harbinger?19

Beech Aircraft Corp.'s just-announced foray into fleet LNG conversions is viewed by company officials as an interim step to the eventual use of hydrogen as an automotive fuel. The new LNG system is now being evaluated in over-the-road tests by several firms, including a trucking company.

The Gas Supplies of Interstate Natural Gas Pipeline Companies, 1972.

Federal Power Commission, Washington, D.C. Bureau of Natural Gas. May 74, 40p
PB-232 685/8WE PC\$3.25/MF\$1.45

The report is a summary of the gas supplies of interstate natural gas pipeline companies for the calendar year 1972. This report is based on data in the recently revised Form 15 reports for the year 1972, which were required to be filed by December 31, 1973. It provides a brief summary of the end of the year total reserves and five year deliverability projections.

NATURAL GAS LEGISLATION. Ogden, W. J. Pub. Util. Forth.; 93: No. 6, 20-24(14 Mar 1974).

Natural gas reserves are quite substantial, but the development of supplies has declined over the past few years. The pricing policy has been a significant factor, and revision of the regulated pricing is necessary. The legislative proposals considered essential are enumerated. Then the considerations for oppositions to deregulation of producer prices are discussed. Some other proposals include the establishment of a national exploration and development company, incremental pricing, and the use of natural gas pipelines as common carriers. (MCW)

OIL AND GAS RESOURCES: DID USGS GUSH TOO HIGH?
R. Gillette.

Science, v.185, July 12, 1974, p.127-130.

If the U.S. Geological Survey is right, the U.S. is at least a decade away from seriously depleting its domestic oil and gas resources. But if several distinguished disbelievers are right, the U.S. is running out of oil and gas right now.

The Role of Gas in a National Energy Policy (IIT Center, Chicago, Illinois 60616, 48 pp). The Institute of Gas Technology's 32nd Annual Meeting of Members and Board of Trustees presented a round table discussion on this topic and the publication is a transcript of that discussion, including an address by the Hon Joseph C. Swidler, Chairman, State of New York Public Service Commission and formerly Chairman of the Federal Power Commission on 'Energy supply in the years ahead'.

US Energy Outlook - Oil and Gas Availability (National Petroleum Council, 1625 K Street NW, Washington DC 20006, \$ 25-00, 768 pp). Background data, methodology and assumptions used in preparing the complete report are here described in detail, including the computer program used to analyse impacts of variables in future production. It constitutes a reference volume of data and projections on petroleum and natural gas production.

US Energy Outlook - Gas Transportation (National Petroleum Council, 1625 K Street NW, Washington DC 20006, USA, \$ 12-00). This volume, prepared by the Gas Transportation Task Group, examines the capital costs of transporting, processing and storing natural, liquefied natural, substitute natural and liquefied petroleum gas for the 1971-1985 period. The report discusses in detail the methodology and data used.

DECLINING DOMESTIC RESERVES - EFFECT ON PETROLEUM AND PEROCHEMICAL INDUSTRY. C.H. Cummings, ed. (Contains papers presented at the 11st National Meeting of AIChE, Dallas, (Tex., 1973)).

AN ANALYSIS OF NUCLEAR GAS STIMULATION.....	45
..... G. C. Werth, B. Rubin, L. Schwartz, and D. Montan	
PROJECT RULISON—SUMMARY OF RESULTS AND ANALYSIS.....	47
..... Miles Reynolds, Jr.	
PROJECT WAGON WHEEL: NUCLEAR EXPLOSIVE STIMULATION OF A NAT- URAL GAS WELL.....	49
..... Leo A. Rogers	
TECHNOLOGY AND ECONOMICS OF TRANSPORTING AND STORING LNG	67
..... Paul C. Johnson	

1973

NATURAL GAS DISCUSSION: Transcript of a November 1973 round table discussion presented at the annual meeting of the Institute of Gas Technology. 47 pages. (The Role of Gas in a National Energy Policy, available without charge from IGT, 3424 S. State St., Chicago, Ill. 60616.)

TITLE: Alternative Regulatory Policies for Dealing with the Natural Gas Shortage
AUTHOR: MacAvoy, P.W.; Pindyck, R.S.
CORPORATE AUTHOR: Massachusetts Institute of Technology, Sloan School of Management
ADDRESS: Cambridge, MA 02139
PUBLICATION DESCRIPTION: Phase II of project to develop an Econometric Policy Model of Natural Gas, reprinted from The Bell Journal of Economics and Management Science, 8(2), Autumn 1973, P. 459-498, 26 references
PUBLICATION DATE: 1973
SPONSOR: National Science Foundation, RAMP Program
ABSTRACT: This report is an analysis of the effects of low wellhead ceiling prices and alternative regulatory policies on the production, demand, reserves, and pricing of natural gas for the rest of this decade. Gas discovery procedures, reserve accumulations, production from reserves, pipeline price increases, and production demand are explained by an econometric model. Results are given from the computer simulation of this model using the various alternative policy assumptions. (PCN)
AVAILABILITY: NTIS, PB 228 007 (\$9.00 paper copy/\$1.45 microfiche)

1973

TITLE: Natural Gas Policy Issues and Options
AUTHOR: Starratt, P.E.; Tensing, A.G.
CORPORATE AUTHOR: U.S. Senate, Committee on Interior and Insular Affairs
ADDRESS: Washington, DC
PUBLICATION DESCRIPTION: Committee Print Serial NC. 91-20 (92-55), A Staff Analysis prepared at the request of Henry M. Jackson (Chairman) pursuant to S.Res.45, A National Fuels and Energy Policy Study, 234 p.
PUBLICATION DATE: 1973
ABSTRACT: From the outset of the Senate's National Fuels and Energy Policy Study, there has been general agreement that the existing system of regulating natural gas prices leaves much to be desired. The Interior Committee's studies and hearings have made clear that new approaches to natural gas pricing are an essential element of national energy policy.-----This analysis of natural gas policy issues is an attempt by the Staff of the National Fuels and Energy Policy Study to describe the natural gas industry, the present system of regulation and the factors contributing to the natural gas shortage. The analysis-----undertakes also to delineate the major options available to Congress with respect to controls over natural gas prices. (Sen. H.M. Jackson, from Memorandum of the Chairman)
AVAILABILITY: GPO (\$1.75)

1975

TITLE: Natural Gas Is a Beautiful Thing?

AUTHOR: Wilson, R.

CORPORATE AUTHOR: Harvard University

ADDRESS: Cambridge, MA

PUBLICATION DESCRIPTION: Bulletin of the Atomic Scientists, 28 (7), 35-40, 23 references

PUBLICATION DATE: 1973, September

ABSTRACT: The hazards of natural gas are reviewed, including air pollution from nitrogen oxides, pipeline and storage tank explosions, asphyxiation, and liquefied natural gas spills. The author feels that regulations to control the hazards are inadequate. Safety studies should be continued and expanded to cover large LNG spills, and data must be published in the open literature. Importation of LNG should be internationally regulated. (APG)

ENERGY YEAR: 1973. Woods, W. P. Pub. Util.

Fortn., 92: No. 9, 17-19(25 Oct 1973).

The energy crisis was not a 1973 phenomenon for the gas industry. The greatest search in the industry's history was under way to find and develop new sources of gas. Reserves of gas for the 50 states have fallen during four of the past five years. In 1970 total reserves went up, reflecting the first inclusion of 26 trillion cubic feet of new gas in Alaska's North Slope. Over the past five years the U. S. has used twice as much gas as has been found. Geologists expect deposits of natural gas to be found under the far water areas bordering the U. S. coast. Other than the proved and potential reserves in Alaska, a potential resource is locked in relatively impermeable rock formations in the western U. S. Experiments in nuclear fracturing to reach this gas are progressing. A major new source of gas may be developed from coal gasification. Other sources of new gas could be through the importation of liquefied natural gas and through the utilization of light hydrocarbon and crude oil feedstock for synthetic natural gas manufacture. (MCW)

DECONTROL: END OF A NOBLE EXPERIMENT.

Moody, R. Jr. Pub. Util. Fortn., 92: No. 9, 20-23(25 Oct 1973).

The wellhead price regulation of natural gas that has lingered for 19 years is discussed. Congressional reluctance to come to grips with natural gas regulation is becoming more disastrous each day. The level of service by pipelines is still dropping and the end is not in sight. The D. C. circuit court is evidently concluding that the Natural Gas Act does not permit the Federal power Commission any power over producer rate matters. Commissioners have sought to make the producer regulation controls workable. Policy makers denounce any consideration of deregulation pointing out falsely that it is a gas industry proposal. The 5th circuit court of appeals states, "FPC has the statutory duty, not only to guard the consumers against super profits reaped from artificially inflated rates, but also to protect consumer interests by making sure that the rate schedule is high enough to elicit an adequate supply." (MCW)

U. S. Energy Outlook: Gas Demand. 1973, National Petroleum Council, 1625 K Street, N.W., Washington, D. C. 20006. 50 pp., paper. \$5.00.

This report was prepared by the Gas Demand Task Group of the National Petroleum Council's committee on the U. S. energy outlook. It consists of the following sections: (1) gas demand summary, (2) economic analysis, (3) future gas demand and the general economy, (4) environmental factors, (5) effects of fuel practice, (6) technological advances and improved utilization efficiency, and (7) distribution of available gas supplies.

GAS SUPPLY SITUATION. Pub. Util. Fortn., 92: No. 9, 63-72(25 Oct 1973).

Some questions regarding the natural gas supply situation were presented to 14 executives of the gas industry. The accent in the coming year will be on fuel sufficiency, but the dominating concerns of the executives have been in the areas of supply, rates, and finance. The question on supply was: "What are your views about the outlook for improving the industry's natural gas supply for public distribution in the light of alternatives being suggested under pressure of the energy crisis, such as production incentives (foreign and domestic), FPC deregulation, additional curtailments and conservation measures, and the outcome of research and development in such areas as synthetic fuel and other substitutes?" Each executive presented his views. (MCW)

GAS SHORTAGE. Tybout, R. A. (Ohio State Univ., Columbus). Pub. Util. Fortn., 91: No. 12, 24-29(7 Jun 1973).

Natural gas regulation is entering a phase in which traditional concepts of rate adjustment appear inadequate. The evidence for this view is the Federal Power Commission's projection of an increasing long-term gap between demand and supply of natural gas. Although possessed of traditional rate-making authority, FPC appears unable to establish market clearing prices and is planning instead to rely on rationing over the next two decades. The prospect is unprecedented and calls for a basic reconsideration of public policy. (auth)

N74-19586# Federal Power Commission, Washington, D.C.
Planning and Development Div.
NATURAL GAS SUPPLY IN THE DECADE OF THE SEVENTIES

Gordon K. Zareski Mar. 1973 19 p refs Presented at the 74th Natl. Meeting of the Am. Inst. of Chem. Engr., New Orleans, 13 Mar. 1973
Avail. NTIS HC \$4.00

The energy situation with respect to natural gas as an energy source was studied. Factors which contributed to the current shortage of natural gas supplied are analyzed. Federal actions to develop the policies necessary to increase the supply of natural gas and to encourage optimum use of this energy source are reported. Possible future sources of natural gas to supplement the shortage are identified. Tables, maps, and graphs are included to show the natural gas supply.
P.N.F.

THE GAS SUPPLY SITUATION IN THE UNITED STATES.

G.K. Zareski.

Air Pollution Control Assoc. J., v.23, no.12,
Dec.1973, p.1023-1027.

PROBLEM OF INCREASING GAS RATES. Pub. Util. Forp.; 92: No. 9, 74-76; 79(25 Oct 1973).

The executives of the gas industry answered a question on the gas rates at the Natural Gas Executives' Forum. The question was: "Assuming that higher-priced offshore supply as well as imports of natural gas and oil will be increasingly important factors in sustaining the public service supply available to customers of both the gas and electric utilities in the United States, what are your views either as to rolling in such increases into the prevailing rate structures subject to state and federal regulation, or otherwise accommodating them in the rate structure and overall revenue requirements?" Each executive presented his views. (MCW)

TITLE: Gas Supply Indicators - A Quarterly Report of Natural Gas Trends in the United States
AUTHOR: Wald, H.P. (Chief)
CORPORATE AUTHOR: Federal Power Commission, Office of Economics
ADDRESS: Washington, DC
PUBLICATION DESCRIPTION: 21 p. report, reprinted in PFC News, 6(52), 3-9
PUBLICATION DATE: 1973, December

ABSTRACT: The purpose of this quarterly report is to provide current information on industry trends affecting gas supply. The criterion for the selection of the statistical series for this report is their value as leading indicators of the industry response to changing economic conditions and regulatory policies. To this end, primary attention is given to series that are reported weekly, monthly, or quarterly. The recent statistics are presented by quarters beginning in 1969. These charts and tables are supplemented with eleven annual series starting in 1955 in order to show long-term trends in key statistical series. It should be noted that the annual series data may differ slightly from the annual totals in the quarterly series in instances where different sources have been used. The "Gas Supply Indicators" include marketed production of gas; producer sales to interstate pipelines; number of active drilling rigs; exploratory and development drilling; and new contract annual sales by producers to interstate pipelines. A number of the national series are disaggregated to show breakdowns for offshore and PFC pricing areas. (Auth, from preface)

Case study of a regional gas supply. F. Holzer (Univ. California, Livermore, USA).

Trans. Am. Nucl. Soc. (USA), vol.17, p.15-16 (Sept. 1973). (American Nuclear Society 1971 Winter Meeting (summaries), San Francisco, Calif., USA, 11-15 Nov. 1973).

An outline is given of how nuclear stimulation of natural gas could supply gas cheaply on a regional basis, whilst keeping background radiation to a safe level. (no refs.)

LNG: Water Explosions.

D. L. Katz.

National Academy of Sciences Washington D C Mar 73,

63p USCG-D-60-74

AD-775 005/2WE PC\$3.75/MF\$1.45

The report directs attention to a proposed solution of a puzzling problem that has been a cause of concern in the shipment of liquefied natural gas--a type of flameless explosion encountered under certain conditions when liquefied natural gas is spilled into water. The report suggests further research to improve understanding of the phenomenon.

Liquefied Natural Gas Technology.

National Bureau of Standards, Boulder, Colo. Cryogenic

Data Center. 5 Oct 73. 54p B-1075

COM-74-10324/3WE PC\$7.00/MF\$7.00;Foreign

PC\$9.50/MF\$9.50

The report contains a bibliography of the applications, storage, handling, production, economics, and safety engineering relative to liquefied natural gas.

MIXED REFRIGERANT CASCADE CYCLES FOR LNG.

Kinard, G. E.; Gaumer, L. S. (Air Products and Chemicals, Inc., Allentown, PA). Chem. Eng. Progr.: 69: No. 1, 56-61(Jan 1973).

Examples of the analysis of the thermodynamic irreversibilities of several mixed refrigerant cycles were presented. Accurate vapor-liquid equilibrium and thermodynamic calculations for mixtures are required for the successful process design of mixed refrigerant cycles having cooling curves with close temperature approaches, which the analysis of thermodynamic irreversibility shows is necessary to obtain optimum cycle efficiency. The lower first cost of the erected plant, which results from the ability to utilize fewer, larger pieces of equipment makes this approach to LNG production advantageous. Another advantage is that the refrigerant consists of components normally found in natural gas plus nitrogen from the atmosphere that results in a plant self-sufficient with regard to refrigerants. (MCW)

COM-73-1039-01 PC-Subscription
National Bureau of Standards, Boulder, Colo.
Cryogenic Data Center.

LIQUEFIED NATURAL GAS. ISSUE NO. 73-1,
JANUARY-MARCH 1973.
Quarterly literature survey.

1973. 24P*

Sponsored in part by American Gas Association,
Arlington, Va.

Paper copy available \$20.00/year.

Descriptions: (*Liquefied natural gas, *Bibliographies), Cryogenics, Low temperature research, Liquefied gases.

The issue lists papers, reports, and patents of interest to engineers and others working in the liquefied natural gas field. The references include author, title, and bibliographic citations and are listed under 23 subject headings. Most references are listed under two or more headings. Each issue also contains a complete author index. The references are obtained from the Cryogenic Data Center's Information System which contains the world's most comprehensive collection of literature in the field of cryogenics.

N74-10716# Bureau of Mines, Bartlesville, Okla.
NATURAL GAS AS AN AUTOMOTIVE FUEL, AN EXPERIMENTAL STUDY
R. D. Fleming and J. R. Allsup 1973 29 p refs
(BM-R1-7806) Avail: NTIS HC \$3.50

A study was conducted to evaluate natural gas as an automotive fuel and to provide guidelines for optimum engine adjustments for low exhaust emissions. The study was conducted using a single-cylinder engine, a multicylinder engine, and a total of eight vehicles. Results from single-cylinder engine tests showed that the light-load, lean-limit misfire region for natural gas begins at an air-fuel ratio between 150 and 160 pct of stoichiometric. Changes in ignition timing significantly influenced emissions of nitrogen oxides and hydrocarbons, but had little effect on carbon monoxide emission. Low emissions can be achieved with current-design engines by adjustment of engine parameters, but only with heavy penalty to engine performance. Emissions from vehicles fueled with natural gas are virtually unaffected by ambient temperature change within the range 20 to 100 F. Author

1973

Foster Associates, Inc. AN ANALYSIS OF THE REGULATORY ASPECTS OF
NATURAL GAS SUPPLY. Research Triangle Park, N.C., Environmental
Protection Agency, Office of Air and Water Programs, Office of
Air Quality Planning and Standards; Distributed by National
Technical Information Service, U.S. Dept. of Commerce, Springfield,
Va., 1973. 1 v. (various pagings)

1973

Plowshare Technology Assessment. Material Resources

Analysis.

Paul A. Bell, and Glenn A. Whan.
Western Interstate Nuclear Board, Lakewood, Colo. Jan 73,
34p
PB-231 038/1WN PC\$4.75/MF\$1.45

The supply of special nuclear material for nuclear explosives
might prove to be a limiting factor in the commercial imple-
mentation of nuclear stimulation of natural gas. The report
presents an analysis of energy and material resources for
nuclear gas stimulation, and discusses some of the factors
which might influence the successful application of this
technology.

Alternate methods for gas stimulation. I. E. Elkins (Ameco Pro-
duction Co., Tulsa, Okla., USA).
Trans. Am. Nucl. Soc. (USA), vol 17, p 16 (Sept 1973). (American
Nuclear Society 1973 Winter Meeting (summaries), San Francisco, Calif.
USA, 11-15 Nov. 1973)

Major gas deposits that might be exploitable exist in three Rocky Mountain
regions. Approximate total gas in place is estimated to be about 640 trillion
cubic feet. Nuclear explosive fracturing, and massive hydraulic fracturing are
discussed as possible extraction techniques. Controlling geological and
engineering factors critical to the success of both methods, capital and logistic
requirements for hypothetical development schedules, and estimated gas supply
rates for these hypothetical development schedules are reviewed and sum-
marized (no refs.)

Plowshare Technology Assessment. Public Participation (With Reference to Nuclear Stimulation of Natural Gas).

Fikry S. Gahin.
Western Interstate Nuclear Board, Lakewood, Colo. Jan 73,
124p NSF-RA-G-73-020
PB-231 617/SWE PC\$9.25/MF\$1.45

The report presents several aspects of Nuclear Stimulation of
Natural Gas including risk analysis of ground motions and
radiation risk, impact of local communities, legal and statutory
problems, insurance and government indemnity, dissemination
of public information and public participation methods in the
decision-making process. The report also includes a published
article on 'Legal Liability and Insurance in Nuclear Stimula-
tion of Natural Gas.'

Industry's appraisal of gas stimulation. R. C. McHugh (Colorado
Interstate Gas Co., Colorado Springs, USA).
Trans. Am. Nucl. Soc. (USA), vol 17, p 13 (Sept 1973). (American
Nuclear Society 1973 Winter Meeting (summaries), San Francisco, Calif.,
USA, 11-15 Nov. 1973).
The economic prospects for producing natural gas by nuclear stimulation are
reviewed. (no refs.)

234

N73-18960* # National Aeronautics and Space Administration.
Lewis Research Center, Cleveland, Ohio.
**PERFORMANCE GAINS BY USING HEATED NATURAL-GAS
FUEL IN AN ANNULAR TURBOJET COMBUSTOR**
Nicholas R. Marchionna Washington Mar. 1973 20 p refs
(NASA-TM-X-2742; E-7236) Avail: NTIS HC \$3.00 CSCL
21E

A full-scale annular turbojet combustor was tested with natural gas fuel heated from ambient temperature to 800 K (980 F). In all tests, heating the fuel improved combustion efficiency. Two sets of gaseous fuel nozzles were tested. Combustion instabilities occurred with one set of nozzles at two conditions: one where the efficiency approached 100 percent with the heated fuel; the other where the efficiency was very poor with the unheated fuel. The second set of nozzles exhibited no combustion instability. Altitude reight tests with the second set showed that reight was improved and was achievable at essentially the same condition as blowout when the fuel temperature was 800 K (980 F).

Author

N73-18771* # National Aeronautics and Space Administration.
Lewis Research Center, Cleveland, Ohio.
**COMPARISON OF COMBUSTION CHARACTERISTICS OF
ASTM A-1, PROPANE, AND NATURAL-GAS FUELS IN AN
ANNULAR TURBOJET COMBUSTOR**
Jerold D. Wear and Robert E. Jones Washington Jan. 1973
23 p refs
(NASA-TN-D-7135; E-7078) Avail: NTIS HC \$3.00 CSCL
21D

The performance of an annular turbojet combustor using natural-gas fuel is compared with that obtained using ASTM A-1 and propane fuels. Propane gas was used to simulate operation with vaporized kerosene fuels. The results obtained at severe operating conditions and altitude reight conditions show that natural gas is inferior to both ASTM A-1 and propane fuels. Combustion efficiencies were significantly lower and combustor pressures for reight were higher with natural-gas fuel than with the other fuels. The inferior performance of natural gas is shown to be caused by the chemical stability of the methane molecule.

Author

**Underground Storage of Natural Gas by Interstate Pipeline
Companies - Calendar Year 1972, Winter 1972-1973.**
Federal Power Commission, Washington, D.C. Bureau of
Natural Gas. Nov 73. 35p
PB-231 842/6WN PCS3.25/MFS1.45

A staff study on the underground storage of natural gas by jurisdictional pipeline companies for the calendar year 1972, is presented. The report shows a net gain of six jurisdictional storage fields during 1972, bringing the number of jurisdictional storage fields to 194 by the end of the 1972 year. Estimated underground storage capacity amounted to 3.281 trillion cubic feet, a 1.9 percent decrease over 1971.

(AD-225237) **NATURAL GAS AS AN AUTOMOTIVE
FUEL, AN EXPERIMENTAL STUDY.** Report of Investigations.
Fleming, R. D. (Bureau of Mines, Bartlesville, Okla. (USA)).
Oct 1973. 32p. NTIS \$3.00.

A study was conducted to evaluate natural gas as an automotive fuel and to provide guidelines for optimum engine adjustments for low exhaust emissions. The study was conducted using a single-cylinder engine, a multicylinder engine, and a total of eight vehicles. Low emissions can be achieved with current-design engines by adjustment of engine parameters, but only with heavy penalty to engine performance. Air-fuel ratio, ignition timing, and ambient temperature were varied. The organic emissions from engines fueled with natural gas were estimated to be 22 to 25 percent as reactive as the emissions produced using gasoline. Levels of exhaust emissions from vehicles fueled with natural gas were unchanged over 10,000 miles of normal driving. (GRA)

73V33390 1973 ISS:00 TN872.A5062 1973 0-806111-03-8; 0-806111-45-3
 301.243 LC-73-8374
 ENERGY UNDER THE OCEANS; A TECHNOLOGY ASSESSMENT OF OUTER CONTINENTAL
 SHELF OIL AND GAS OPERATIONS; BY DON E. KASH (AND OTHERS) FOREWORD BY
 JOSEPH COATES.
 OKLAHOMA. UNIVERSITY. SCIENCE AND PUBLIC POLICY PROGRAM. TECHNOLOGY
 ASSESSMENT GROUP.
 (1ST ED.) UNIVERSITY OF OKLAHOMA PRESS NORMAN; XXII, 378 P. ILLUS. 23
 CM.
 \$20.00 INCLUDES BIBLIOGRAPHICAL REFERENCES.
 LC:PETROLEUM IN SUBMERGED LANDS -- UNITED STATES. ♦♦ GAS, ♦♦
 ♦♦ NATURAL ♦♦ -- UNITED STATES. CONTINENTAL SHELF -- UNITED STATES.
 TECHNOLOGY ASSESSMENT -- UNITED STATES. ENVIRONMENTAL POLICY -- UNITED
 STATES.
 ADDED:N♦US♦♦ KASH; DON E.
 LA: TN872.A5062 1973
 MAIN-CORP TRACE-TITL♦AUTH♦ CATLG BY-LC
 / / AVAIL: LANGLEY

73V43304 1973 ISS:00 TN880.A1153 1973 0-853344-86-8 333.82
 LC-73-172954
 OUTLOOK FOR ♦♦ NATURAL ♦♦ ♦♦ GAS--A ♦♦ QUALITY FUEL.
 EDITED BY PETER HEPPLE.
 INSTITUTE OF PETROLEUM, LONDON.
 APPLIED SCIENCE PUBLISHERS ON BEHALF OF THE INSTITUTE OF PETROLEUM
 (BARKING, ENG.) VIII, 268 P. ILLUS. 23 CM.
 7.00 "PROCEEDINGS OF THE INSTITUTE OF PETROLEUM SUMMER MEETING,
 'NATURAL GAS--OUTLOOK FOR A QUALITY FUEL,' HELD AT THE PALACE COURT
 HOTEL, BOURNEMOUTH, 6-9 JUNE, 1972." INCLUDES BIBLIOGRAPHICAL
 REFERENCES AND INDEX.
 LC: ♦♦ GAS, ♦♦ ♦♦ NATURAL ♦♦ -- CONGRESSES. ♦♦ GAS ♦♦
 AS FUEL -- CONGRESSES.
 ADDED:HEPPLE; PETER; ED. ♦♦ NATURAL ♦♦ ♦♦ GAS--OUTLOOK ♦♦
 FOR A QUALITY FUEL.
 MAIN-CORP TRACE-TITL♦AUTH♦ CATLG BY-LC

1973

TITLE: SMG in the U.S. Energy Balance
AUTHOR: Linden, R.N.
CORPORATE AUTHOR: Institute of Gas Technology
ADDRESS: Chicago, IL
PUBLICATION DESCRIPTION: 10 p. reprint from Gas, 49, p. 29-33, July, and p. 61-66, August, 13 references, also published as "Role of SMG in U.S. Energy Balance", Pipe Line Industry, 39, 23-27, based on paper presented at 18th Operating Section Distribution Conference, Washington, DC, May 18-17, 1973
PUBLICATION DATE: 1973, July 6, August
ABSTRACT: The many problems involved in the development of a large SMG industry are described. Many uncertainties exist, one of which will be the formulation of government policies and regulations. Other obstacles are the availability of feedstocks, environmental siting problems, and costs. Graphs and tables of forecasts by the Institute of Gas Technology and the Bureau of Mines are given. (JMC)
AVAILABILITY: Gas Magazine, Suite 735, #151 Southeast Freeway, Houston, TX 77027

TITLE: Substitute Natural Gas: Processes, Equipment, Costs
AUTHOR: Presler, S.A.; Ireland, J.N.
ADDRESS: Presler, P.O. Box 86, Cathedral Station, New York, NY 10025; Ireland, 5a Bon Air Ave., New Rochelle, NY 10804
PUBLICATION DESCRIPTION: Chemical Engineering, 79(23), 94-106, 32 references
PUBLICATION DATE: 1972, October 16
ABSTRACT: Due to the increasing demand for natural gas, substitute or synthetic natural gas will have an increasingly important role in the energy picture in the future. A detailed survey is given of all the important commercial processes now in use to manufacture this fuel. A brief estimate is given of future expected costs. (JMC)
AVAILABILITY: Chemical Engineering, McGraw Hill Bldg., 1221 Avenue of the Americas, New York, NY 10020 (\$2.00)

TP490.A3
v.18

LNG Technology.

LNG—U. S. and Foreign Traffic—An Overview, A. PASTUHOV, *Gazette U. S. A., Inc.*..... 1
Cryogenic Technology and Scaleup Problems of Very Large LNG Plants, J. M. BOURGUET, *TEAL*..... 9
Heat Transfer Problems in Liquefied Natural Gas Plants, L. E. DEAN, *Phillips Petroleum Company*..... 27
Explosive Boiling of Liquefied Hydrocarbon/Water Systems, T. ENGER, D. E. HARTMAN, and E. V. SEYMOUR, *Shell Pipe Line Corporation*..... 32

Advances in Cryogenic Engineering, v.18.
(Proceedings of the 1972 Cryogenic Engineering Conference Nat. Bur. Stds., Boulder, Colorado, Aug. 9-11, 1972). K.D. Timmerhaus, Ed.

1972

N74-16657 North Carolina State Univ., Raleigh.
BALANCING THE SUPPLY AND DEMAND FOR NATURAL GAS
Edward W. Erickson and Robert M. Spann In Denver Univ. Balancing Supply and Demand for Energy in the US 1972
p 91-106 refs [For availability see N74-16651 07-34]
An analysis of the supply and demand factors involving natural gas as an energy source was conducted. The need for a workable policy for natural gas production and use is stressed. Factors which have contributed to the lessening supply are reported. Measures for improving the situation are proposed. Tables of data are included to show: (1) predicted and actual discoveries of crude oil and natural gas from 1953 to 1987. (2) trends in well head price of natural gas compared with quantity of natural gas discoveries. (3) effects of oil and gas prices and other variables on oil and gas discoveries, and (4) projections of non-associated natural gas prices and required discoveries for the period of 1972 to 1985. Author

N74-19587# Federal Power Commission, Washington, D. C.
Analysis and Procedures Div.
NATURAL GAS AVAILABILITY: PRESENT AND FUTURE
Gordon K. Zarecki May 1972 13 p Presented at Symp. on Gaseous Fueled Vehicles and the Environ., Washington, D. C., 24-26 May 1972
Avail: NTIS HC \$4.00

An analysis of the availability of natural gas and gas reserves in the United States is presented. The actual and projected demand for gas during the 1950 to 1990 time period is analyzed. Historical trends in natural gas production and reserve additions are illustrated. A graph of the annual demand for natural gas is plotted to show the levels of domestic productive capacity with annual reserve additions of 30, 25, and 20 trillion cubic feet. P.N.F.

N74-18588 Mitre Corp., McLean, Va.
THE INTERNATIONAL ASPECTS OF IMPORTING NATURAL GAS
Robert A. Charpie In its Symp. on Energy Resources and the Environment, Vol. 1 12 Apr. 1972 p 136-153 (For availability see N74-18582 09-34)
Importation of liquefied natural gas from Algeria to eliminate the expected natural gas shortage in the U.S.A. requires the adjustment of regulatory limitations to foreign currencies, the building of cryogenic tankers to transport liquid methane, and the building of terminal facilities in the east coast of the United States. G.G.

1972

(HIT-500) STUDY OF THE FUTURE SUPPLY OF NATURAL GAS FOR ELECTRICAL UTILITIES. (Hittman Associates, Inc., Columbia, MD USA). Feb 1972. 42p. (PB-209-285).

The availability of natural gas as a low sulfur fuel for electrical production was examined in light of historical usage and availability. The goal was to ascertain not only near term but extended demands. Projections were made out through the year 2000. Such alternatives as coal and oil shale gasification, liquid natural gas (LNG), and well stimulation were evaluated. The use of natural gas has been and will continue to be an important source of fuel within the United States. It represents a very clean fuel and, as a result, a fuel that can become an important control in the fight against pollution. Most industry spokesmen are forecasting a gas shortage during the 1972 through 1975 time period. The bulk of the solutions will not be available until the latter 1970s. These include such items as LNG import, synthetic gas production, and field stimulation. Gas power generation by electric utilities will decline on a percentage basis due to these shortages and will continue beyond the crisis due to high gas prices. The overall gas consumption, however, will continue to rise. This high consumption level will be met almost entirely by internal production until the latter 1970s. Imports from Canada and Mexico will yield only a small percentage of our demand. Beyond this, LNG imports will play an ever-increasing role. An attractive economic picture could yield LNG capturing 10 percent of the United States market by 1981 and increasing during the following years. Liquid natural gas will meet a large part of the United States demand, but cannot continue well into the 2000s. If gas is to continue its role, coal gasification must pick up the slack. This process can supply sufficient gas for at least another 100 years. This process is currently under pilot-plant investigation and could be developed to full-scale capabilities in the 1980's. (auth)

CN-129,612
1972
NATIONAL GAS SUPPLY AND DEMAND 1971-1990.
(Bureau of Natural Gas - Staff Rept. no.2).
Feb.1972. 166p.

Federal Power Commission
Bureau of Natural Gas

Gases, Natural
Power sources

(1 c. given to Mike Ellis)

L-5-31-73

1972

TITLE: Improving the Utilization of Natural Gas in Major Steel Mill Applications
AUTHOR: Meshitt, J.D.
CORPORATE AUTHOR: Institute of Gas Technology
ADDRESS: Chicago, IL 60616
PUBLICATION DESCRIPTION: Paper presented at The East Ohio Gas Company Seminar on Fuel Conservation in the Steel Industry, Cleveland, OH, April 20 1972, 25 p., 5 references

PUBLICATION DATE: 1972
SPONSOR: Consolidated Natural Gas Service Co. Inc.; Southern California Gas Co.; American Gas Association
ABSTRACT: A project to investigate the effects of existing and new technology on the efficiency of industrial gas utilization is described. The project objectives are: identify processes where technology for improved utilization of natural gas can be economically applied; study effects of antipollution legislation on fuel usage in industrial processes; investigate the effects on fuel usage of changes in process technology; investigate the applicability of existing and new technology for improved utilization of natural gas; and recommend process and equipment modifications and research programs. The following processes were selected for in-depth study: ingot heating; slab, bloom, and billet heating; and coil and continuous annealing processes. (APC)

Medium-term prospects and guidelines in the community gas sector Commission of the European Communities, Brussels (Belgium). 1972 91 PAGES

AVAIL- HTIS HC \$7.75
*ENERGY POLICY, *ENERGY TECHNOLOGY, *NATURAL GAS
ENERGY STORAGE, ENERGY TRANSFER, EUROPE, PIPELINES
C03 N79-21604 0

WHEN THE WELL RUNS DRY.

R.H. Williams

Environment, v.14, no.5, June 1972, p.19-20,
25-31.

Some of the difficulties confronting the natural-gas policy makers are outlined. In particular, some 'demand forecasts' and resource estimates are examined, and various potential substitutes for domestic natural gas are briefly reviewed.

228

1972

N72-18761# Bureau of Mines, Bartlesville, Okla. Energy Research Center.

CLEAN AUTOMOTIVE FUEL: ENGINE EMISSIONS USING NATURAL GAS, HYDROGEN-ENRICHED NATURAL GAS, AND GAS MANUFACTURED FROM COAL (SYNTHANE) D. B. Eccleston and R. D. Fleming Feb. 1972 15 p refs (TPR-48) Avail: NTIS

Natural gas and mixtures of natural gas and hydrogen were used as fuels in a laboratory engine to determine the relationship of emissions to air-fuel ratio and to establish practical lean limits for air-fuel ratio. Synthetic gas manufactured from coal (Synthane) and natural gas were used as fuels in a vehicle to obtain comparative data on emissions and performance. Results showed that lean limits for air-fuel ratio when using hydrogen-enriched natural gas were extended significantly beyond that of natural gas. Synthane produced exhaust that was significantly less reactive than exhaust from natural gas. With lean air-fuel ratios, the acceleration performance of a vehicle fueled with Synthane was improved over its performance when fueled with natural gas. Author

73V38743 1972 ISS:00 TN882.67635 0-903545-02-0 338.4766570942

LC-73-151781

BRITAIN'S ♦♦ NATURAL ♦♦ ♦♦ GAS. ♦♦
♦♦ GAS ♦♦ COUNCIL (GREAT BRITAIN)
♦♦ GAS ♦♦ COUNCIL LONDON, (47) P. CHIEFLY ILLUS. (CHIEFLY
COL.), COL. MAPS. 30 CM.

COVER TITLE.

LC: ♦♦ GAS, ♦♦ ♦♦ NATURAL ♦♦ -- GREAT BRITAIN. ♦♦ GAS,
♦♦ NATURAL ♦♦ -- NORTH SEA.

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MAIN-CORP TRACE-TITL CATLG BY-LC

/ / PUBL IN UNITED

73V40272 1972 ISS:00 TN880.757 1972 0-901360-03-1 553.285

LC-73-159113

A/TIRATSDO, ERIC NESHAN.

♦♦ NATURAL ♦♦ ♦♦ GAS: ♦♦ A STUDY, BY E. N. TIRATSDO.

2ND ED. SCIENTIFIC PRESS LTD, BEACONSFIELD, XVI, 400 (32) P. ILLUS.,
MAPS. 26 CM.

5.50 (\$18.50 U.S.) INCLUDES BIBLIOGRAPHICAL REFERENCES.

LC: ♦♦ GAS, ♦♦ ♦♦ NATURAL. ♦♦

MAIN-AUTH TRACE-TITL CATLG BY-LC

/ / PUBL IN UNITED

CM-129,699

1971

PROCESSES AND EQUIPMENT INVOLVING LIQUEFIED NATURAL
GAS (LNG) AND LIQUID METHANE - BIBLIOGRAPHY OF
REFERENCES. (Prepared by NBS for the American Gas
Assoc.). Sept.30,1971.

National Bureau of Standards
American Gas Association

NBS B-792

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Gases, Natural

Methane, Liquid

Gases - Liquefaction

190,178,001
L-6-25-73

74V10176 1971 ISS:00 TP756,U54 1971 665.74 LC-73-600533

UNDERGROUND STORAGE OF ♦♦ NATURAL ♦♦ ♦♦ GAS ♦♦ BY
INTERSTATE PIPELINE COMPANIES.

UNITED STATES. FEDERAL POWER COMMISSION. BUREAU OF ♦♦ NATURAL ♦♦
♦♦ GAS. ♦♦

WASHINGTON; 13, 25 P. ILLUS. 28 CM.

COVER TITLE. INCLUDES BIBLIOGRAPHICAL REFERENCES.

LC: ♦♦ GAS: ♦♦ ♦♦ NATURAL ♦♦ -- UNDERGROUND STORAGE --
UNITED STATES.

ADDED:N+US♦♦

MAIN-CORP TRACE-TITL♦ CATLG BY-LC

73V28505 1970 ISS:00 TN880.D63 0-901253-17-3 553.285 LC-72-549102

R/DOHERTY, CHARLES HUGH.

NEW ♦♦ GAS ♦♦ FOR OLD: THE STORY OF NATURAL GAS; BY C. H.
DOHERTY.

CLIFTON BOOKS, BRIGHTON; IX, 202 P.; 4 PLATES. ILLUS.; MAPS. 22 CM.

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LC: ♦♦ GAS, ♦♦ ♦♦ NATURAL. ♦♦

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A/ZAFFARANO, RICHARD F.

♦♦ NATURAL ♦♦ ♦♦ GAS ♦♦ LIQUIDS: A REVIEW OF THEIR ROLE
IN THE PETROLEUM INDUSTRY, BY RICHARD F. ZAFFARANO.
U.S. BUREAU OF MINES (FOR SALE BY THE SUPT. OF DOCS., U.S. GOVT.
PRINT. OFF., WASHINGTON) 22 P. ILLUS. 27 CM.
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ECONOMICS OF STIMULATING ♦♦ NATURAL ♦♦ ♦♦ GAS ♦♦
RESERVOIRS WITH NUCLEAR EXPLOSIVES; REPORT.
ATOMIC INDUSTRIAL FORUM. COMMITTEE ON INDUSTRIAL PLOWSHARE
APPLICATIONS.

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WELLS. UNDERGROUND NUCLEAR EXPLOSIONS.
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TYPE 73N73283/2

73N73283 PB-184353 PH-22-68-58 PROJ. 8926 69/05/00 559 PAGES

UNCLASSIFIED DOCUMENT

LING: A SULFUR-FREE FUEL FOR POWER GENERATION FINAL REPORT
INSTITUTE OF GAS TECHNOLOGY, CHICAGO, ILL. AVAILABLE
♦ELECTRIC POWER PLANTS♦NATURAL GAS♦ECLOGY♦ECONOMICS♦ELECTRIC
GENERATORS♦SOCIOLOGY

SYNTHETIC FUELS

1974

SYNTHETIC FUELS: WILL GOVERNMENT LEND THE OIL INDUSTRY A HAND. Gillette, R. Science; 183: No. 4125, 641-643(15 Feb 1974).

The United States possesses immense deposits of coal and oil shale. The combined effects of government and industry research, and the exploding prices of conventional petroleum make synthetic oil and gas within a comfortable profit margin. At a shale oil plant, the production costs are about the same as the current price of conventional oil in the USA. Government funding is not necessary, since estimated costs of a shale or gasification plant are not much higher than nuclear power plants that are being built privately. The AEC concludes that a massive synthetic fuel program cannot now be justified, but calls for a "Synthetic Fuels Pioneer Program." (auth)

Technology Review, v.76, no.6, May 1974, p.44-

Synthetic Fuels

Substitute natural gas (SNG), synthetic crude petroleum (syncrude), and methyl alcohol (methanol) can all be produced from coal and from oil shale. Studies of such processes have not been conducted on a large scale in this country until recently, because of the domestic abundance of cheap natural gas and petroleum. Intensive work on coal-based processes was carried out in Europe prior to 1945, however, and it resulted in plants which supplied Germany's wartime fuel needs. After World War II, development in Europe also stopped, because of the availability of cheap foreign crude oil.

1974

SYNTHETIC CRUDE OIL: IS IT FEASIBLE YET? Energy Int.; 11: No. 2, 25-27(Feb 1974).

The Athabasca tn. sands contain as much oil as Saudi Arabia and from their tar synthetic crude can be prepared. Since 1967, the Great Canadian Oil Sands Company has been producing 45,000 bbls/day as a result of a \$300 million investment. The other well-known oil companies are now investing in the venture in the Canadian sands. The extraction problems are discussed and GCOS is still operating at a loss, but is close to breakeven point and is planning an increase. The group of the other oil companies is producing 125,000 bbls/day and it is thought this may be justifiable. The conversion of coal is gaining momentum and the processes of liquefaction and gasification being tested by all the companies are discussed. COGAS is a venture of six oil companies and their process of developing gasification of char from coal pyrolysis making pipeline quality gas and high-quality, low-sulfur synthetic crude is described. The process produces 27,000 bbls/day of gas, sulfur, phenols, and ammonia, all from 25,000 tons/day of coal and compares well with the most efficient Synthane-Hydrane process. The cost of synthetic natural gas made by COGAS cannot be evaluated at this time. (MOW)

1974

BEST SUBSTITUTE FOR PETROL MAY BE PETROL. Valery, N. New Sci.; 61: No. 882, 203-205(24 Jan 1974).

The calorific values of the fuels being studied were compared. Petrol is the most efficient, followed by methane in the form of LNG, then methanol and liquid hydrogen. Hydrogen is attractive only on a weight basis, but the storage problems are serious for its liquefied state. Liquid methane requires the same costly storage equipment as hydrogen, making it prohibitive for road vehicles. Methanol is a clean burning fuel and manufacturing processes are being developed. Tests are being sponsored by the Office of Coal Research and the American Gas Association and large-scale commercial plants could be capable of being on-stream by 1978. Synthetic crude oil has been manufactured in Sasol, South Africa since 1955. The technique is based on the Fischer-Tropsch process for synthesizing oil from coal, not only making synthetic petrol from coal but also the full range of products normally derived from crude oil. (MCW)

A NEW LOOK AT CATALYSIS.

T.E. Fischer.

Physics Today, v.27, no.5, May 1974, p23-28.

By making catalysis more of a science than an art, surface scientists can help solve the current high-priority problem of transforming fossil fuels into more usable forms.

PLANNING FOR PRODUCTION OF SYNTHETIC HYDROCARBON FUELS.

Whiting, J. M. (Bank of Montreal). Mining Congr. J.; 60: No. 2, 51-60(Feb 1974).

From 1970 through the year 2000 it is projected that the U. S. and Canada demand will be 4420 Q Btu of energy. The continental resource availability of domestic crude oil, natural gas, coal, oil shale, and oil sands is considered. Three development programs are presented for coal gasification, oil sands, and oil shale, each of which would develop an energy output equivalent to four million bbl/day of oil by 2000. (MCW)

N74-18630# Bureau of Mines, Bartlesville, Okla.
BUREAU OF MINES ENERGY PROGRAM, 1972

Bill Linville and John D. Spencer Aug. 1973 117 p refs
(PB-224399/6GA: 8M-IC-8612) Avail: NTIS HC \$4.25 CSCI 21D

During calendar year 1972, the Bureau of Mines was engaged in some 20 major areas of research for development of new and improved efficient methods of conservation and utilization for petroleum and natural gas, oil shale, and coal. Numerous projects are described. Based on this research, 186 technical reports were published by the Bureau or others, and numerous other reports were prepared for U.S. Government agencies, State agencies, and organizations engaged in cooperative research programs with the Bureau. Author: (GRA)

(BNL-18430) EVALUATION OF THE TECHNICAL, ECONOMIC, AND ENVIRONMENTAL FEATURES OF A SYNTHETIC FUELS ECONOMY BASED ON FUSION REACTORS.

Powell, J.; Salzano, F.; Sevlan, W.; Hoffman, K.; Besler, P. (Brookhaven National Lab., Upton, N. Y. (USA)). Nov 1973. 103p. Dep. NTIS \$7.25.

The technology, economics, and environmental effects of producing synthetic fuels based on fusion (CTR) reactors are assessed. In this analysis, H₂ gas is produced by electrolysis of water (electricity is supplied from CTR reactors); H₂ liquid is produced from H₂ gas by conventional liquefaction; and methanol is produced by reaction of CO₂ (extracted from the atmosphere) and H₂ gas. Four U. S. energy systems from 2020 AD with different degrees of CTR implementation are compared in terms of overall cost and environmental effects. In System A, no CTR input is assumed, and the energy inputs are nuclear electric, hydropower, coal, oil, and gas; in System B, CTR's replace 50% of nuclear electric; in System C, CTR's supply all electrical demand, plus electricity to make enough synthetic fuels to replace all oil and gas imports, as well as the elimination of strip mining; and in System D, CTR's supply all electrical demand and virtually all fuel demand. CTR reactor costs are analyzed in detail for a range of containment parameters, reactor outputs (5 GW(e) to 20 GW(e)) and first wall loadings (1 to 4 MW(th)/m²), and for DT and catalyzed DD fuel cycles. (auth)

CN-140, 562

(CONF-730807-3) HYDROGEN AND SYNTHETIC FUELS FOR THE FUTURE. Michel, J. W. (Oak Ridge National Lab., Tenn.). 1973. 36p. Dep. NTIS \$4.00.

Synthetic fuels can be produced at remote, well-regulated plants and would not contribute to the primary pollution problems that exist in urban centers. Production, storage, transportation, end uses, and overall systems analyses are evaluated for new fuel systems. Emphasis is on hydrogen and other fuels from nonfossil sources, but a section is included on the use of coal to produce hydrogen and methanol. Comparative characteristics of hydrogen, ammonia, hydrazine, methanol, methane, ethanol, and gasoline (C₈H₁₈) are tabulated. (JCW)

CN-129,827, Mac. 1973
FUELS FOR ENERGY. (Special Issue). 28p.

Electronic Progress, v.15, no.2 Summer 1973

The fuels refinery of the future.
An ecologically compatible refining.
Hydrodesulfurization of petroleum fractions.
Substitute natural gas: energy extender.

OIL SHALE, COAL, AND THE ENERGY CRISIS, Eng. Weichman, B. E. (Superior Oil Co., Houston, TX). Chem. Eng. Progr.: 69: No. 5, 94-95 (May 1973).

Oil shale and coal are domestic reserves that are large enough to make up the anticipated energy deficit between now and the year 2000. Oil shale containing nahcolite and dawsonite can be processed in an integrated operation into products for clean utility fuel and nahcolite can be used in a dry scrubbing process to reduce SO_2 and possibly NO_x stack emission to lawful limits. Dawsonite can be processed into sodium compounds that can be used in the treatment of waste water. The integrated process is described. The nahcolite can be used behind an electrostatic precipitator as a granular filter that can absorb the SO_2 , as well as trap particulates that pass through the precipitator. This would allow coal of any sulfur content to be burned as clean energy and potentially free for use. A plant producing 50,000 bbl/day of oil could be on stream by 1981. It is estimated that these plants could eliminate the total energy deficit without imports by 1998. (MCW)

1973

(WASH-1281-5) COAL AND OIL-SHALE PROCESSING AND COMBUSTION. Subpanel Report V Used in Preparing the AEC Chairman's Report to the President. Crensz, W. (USAEC, Washington, D. C.). 27 Oct 1973. 319p. Dep. NTIS \$19.00.

Optimistic projections indicate that by 1985 an industrially supported oil-shale industry of about 1,000,000 bbl/day can be developed. From coal, about 1,000,000 bbl/day production of oil and 1.5 trillion cf/year of pipeline-quality gas might be available by 1985, if the Federal government has a strong commitment to achieve that goal. Achievement of this goal would provide for rapid industrial expansion after 1985, but first the threshold must be overcome. During the near-term period, the development of reliable stack gas cleanup systems must be accomplished in order to insure that coal can be burned in central power plants in an environmentally satisfactory manner. Simultaneously, new coal combustion techniques must be developed that have greater efficiency than conventional systems. Stack gas cleanup consumes from 3 to 7% of the power output of a plant. Pressurized fluidized-bed combustion systems will be developed that have the capability of higher thermodynamic efficiencies than conventional systems and also avoid the power losses in stack gas cleanup. The proposed supporting research is an effort parallel with the coal gasification and liquefaction research and focuses sharply upon the equipment and material problems that are encountered in the hostile conditions used in these processes. Commercial development can only follow when there is reasonable assurance of reliable continuous plant operation. The solution to problem areas is usually less costly in the laboratory than in a pilot plant operation. Proposed funding levels for the five subprograms (total \$1.22 billion for 5 years) included in this review are presented. (auth)

1973

(WASH-1281-7) ADVANCED METHODS OF OIL AND GAS PRODUCTION FROM FOSSIL FUELS. Subpanel Report VII Used in Preparing the AEC Chairman's Report to the President. Fleming, E. H. (USAEC, Washington, D. C.). 13 Nov 1973. 139p. Dep. NTIS \$9.50.

The program recommended by the subpanel consisted of six subprograms. In order to meet the \$310 million program level recommended by the Overview Panel, the subprograms for in situ coal gasification and recovery of oil and gas from tar sands and heavy oils were eliminated. The remaining four subprograms and objectives are: (1) oil recovery from fluid injection, demonstrating optimum applications of existing and improved methods for some 60 billion barrels now technologically but not economically recoverable; (2) oil and gas from stimulating tight formations using nuclear explosives, large-volume hydraulic fractures, and chemical explosives; (3) oil from oil shale by developing appropriate fracturing techniques (e.g., nuclear explosives, chemical explosives, partial mining, hydraulic fracturing, or combinations thereof) and processing methods (e.g., in situ combustion, circulation of hot gases); and (4) oil and gas from advanced drilling technology (primarily jet drilling and spark drilling). The predicted results of the contribution of each subprogram to production levels by 1985 and 1995 are presented, and the comparative roles of government and industry are briefly discussed. (LMT)

74NL9047# ISSUE 10 PAGE 1167 CATEGORY 13 SLA-73-946
 AT(29-1)-789 73/10/00 17 PAGES UNCLASSIFIED DOCUMENT
 FRACTURE OF COAL AND OIL SHALE FOR IN SITU PROCESSING OR REMOTE
 REMOVAL A PROPOSAL SUPPORT DOCUMENT
 A/TYLER, L. D.; B/WEART, W. D.
 SANDIA LABS., ALBUQUERQUE, N.MEX. AVAIL:NTIS
 HC \$3.00
 /*COAL/*FRACTURE MECHANICS/*SHALE CIL/ EXPLOSIVES/ HYDRAULIC
 EQUIPMENT/ MATERIALS RECOVERY/ REMOVAL

Gregory, D. P., and Rosenberg, R. B.,
 "Synthetic Fuels for Transportation
 and National Energy Needs", paper
 presented at SAE meeting May 15, 1973,
 avail. Inst. Gas Tech, Chicago,
 Illinois, 60616.

NTIS-30123# Bureau of Mines, Morgantown, W.Va.
 BUREAU OF MINES ENERGY PROGRAM, 1971
 John D. Spencer and Bill Lenville 1972 108 p refs
 (BM-IC-8551) Avail: NTIS HC\$7.50

In 1971 increase emphasis was placed on the production of
 fluid fuels and chemicals from coal. Advances were achieved in
 the development of the Synthene and Hythane gasification
 processes for producing pipeline gas from coal, and progress was
 made in research on solid wastes utilization, and on liquid fuels
 production from coal. Coal mine safety, solid waste disposal and
 utilization, coal preparation and transport, and fundamental
 research on coal and related products also continued to be the
 subject of extensive research. Improved methods for extracting
 petroleum and natural gas without surface and subsurface
 pollution are discussed. This research was highlighted by studies
 of the fracturing systems of reservoir rocks, including optimum
 fracture mapping and fracturing techniques to achieve optimum
 production of oil and gas. Oil recovery by water or gas flooding,
 by steam injection, on the identification of oil spills, and on
 means to reduce vehicular exhaust emissions is summarized.

Author

N74-15449# Oak Ridge National Lab., Tenn.
 STORAGE AND TRANSPORTATION OF SYNTHETIC FUELS.
 A REPORT TO THE SYNTHETIC FUELS PANEL
 J. E. Johnson Sep. 1972 20 p refs
 (Contract W-7405-eng-26)
 (ORNL-TM-4307) Avail: NTIS HC \$3.00

A review of the problems associated with the storage and
 transportation of energy by the major candidate synthetic fuel
 systems hydrogen and hydrogen-derived fuels, such as ammonia
 and methanol is presented. Particular emphasis has been placed
 on the identification of limiting technologies and on areas in
 which research and development efforts should be undertaken
 to contribute solutions to the nation's growing problems of energy
 resources, transmission and conversion. Author (NSA)

SYNTHETIC FUEL ENERGY SYSTEMS BASED ON
 FUSION REACTORS; TECHNOLOGY, ECONOMICS, AND ENVIRONMENTAL EFFECTS. Powell, J. R.; Salzano, F. J.;
 Sevilan, W. A.; Hoffman, K. C. (Brookhaven National Lab., Upton,
 NY). Trans. Amer. Nucl. Soc.; 16: 239-240(Jun 1973).
 From 19th annual meeting of the American Nuclear Society;
 Chicago, Illinois, USA (10 Jun 1973).

1972

N73-33738# Atomic Energy Commission, Washington, D.C.
HYDROGEN AND OTHER SYNTHETIC FUELS: A SUMMARY OF THE WORK OF THE SYNTHETIC FUELS PANEL
Sep. 1972. 135 p refs
(TID-26136) Avail: NTIS MF \$1.45; SOD HC \$2.25

The development of hydrogen as a synthetic fuel is attractive because it is essentially clean burning, the main combustion product being water; it may be substituted for nearly all fuel uses; it can be produced from domestic resources; it is available from a renewable and universal raw material-water; and nearly all primary energy sources, nuclear, solar, etc., may be used in its production. The main obstacles to the use of hydrogen as a universal fuel are its high cost relative to the current low prices for fossil fuels and, for some applications, the unresolved problems of handling a low-density or a cryogenic fluid. Safety considerations are discussed. The various options for the production of hydrogen, namely, electrolysis, thermochemical, biological, radiolytic, and various combinations, and the production of other synthetic fuels, particularly those made from hydrogen are discussed. Other synthetic fuels considered include ammonia (NH₃), hydrazine (N₂H₄), methanol (CH₃OH), methane (CH₄), ethanol (C₂H₅OH), and gasoline (C₈H₁₈).
NSA

"Synthetic Fuels, What, When?"
Chemical Engng., p. 62, April 17, 1972.

PROSPECTS FOR SYNTHETIC FUELS IN THE UK.
Day, G. V. (Programmes Analysis Unit, Chilton, Eng.). Futures; 4: No. 4, 331-43(Dec 1972).

An answer is given to the question: "What happens when oil and natural gas production start to decline?" Forecasts of the world production and demand for oil and gas are reviewed briefly and it is concluded that large scale production of synthetic oil from coal and oil shale in particular will have to start by about the year 2000, and that energy intensive processes for the production of fuels such as methanol and hydrogen from non-fossil sources will have to start on a large scale during the period 2000 to 2030. (auth)

1972

FB-228 328/9
Federal Council for Science and Technology,
Washington, D.C. Extraction of Energy Fuels
Panels.
EXTRACTION OF ENERGY FUELS.
Open file rept.
Sep 72, 254p BuMines-OFR-30-73

Descriptors: (*Fuels, *Extraction), (*Oil recovery, Stimulation), (*Gas production, Stimulation), (*Coal, Extraction), (*Coal gasification, In situ combustion), Requirements, Forecasting, Bituminous sands, Oil shale, Organic wastes, Coal mining, Energy.

The purpose of the research is to identify and implement the most promising set of research programs in the energy field. The technical assessment contained in this report is an initial appraisal of the following functional areas: (I) Stimulation of petroleum and natural gas production, (II) production of oil from tar sands, (III) development of oil shale, (IV) underground gasification of coal, (V) oil and gas production from organic wastes, and (VI) primary extraction of coal. The report covers short-term needs (1972-80), intermediate-term needs (1975-85), and long-term needs (1980-2000).

GASIFICATION OF SOLID FOSSIL FUELS IN A MICROWAVE DISCHARGE.

Y.C. Fu, B.D. Blaustein and I. Wender.
Chem. Eng. Sym. Series, v.67, no.112, 1971, p.47-55.

Gasification of solid fuels including lignite, high volatile A bituminous coal, oil shale, kerogen, gilsonite, and tar sands in a microwave discharge in argon yields hydrogen, carbon monoxide, and gaseous hydrocarbons. The extent of gasification appears to be related to the carbon content of the solid. High initial rate of production of various components of gases decrease rapidly with time in the early stages of reaction. In a carbon dioxide discharge, the product species present are oxidized to yield carbon monoxide; in a hydrogen discharge, the formation of hydrocarbons is enhanced.

"Synthetic Liquid Fuels from Oil Shale, Tar Sands, and Coal", Hydrocarbon Symposium, Quart. Colo. School of Mines, V. 65, n. 4, October, 1970.

CE-140,533

DEMONSTRATION PLANT CLEAN BOILER FUELS FROM COAL
(1974)
PRELIMINARY DESIGN/CAPITAL COST ESTIMATE.
(Interim rept.1). (1974). 77p.

Office of Coal Research,
(Washington, D.C.)
Parsons, Ralph M., Co.
Los Angeles, Calif.
Contract 14-32-0001-1234

R&D
Rept.82

Coal - Gasification
Fuels - Synthesis

189,652/144
L-3-7-74

CE-140,568

1974
COAL TECHNOLOGY: KEY TO CLEAN ENERGY. ANNUAL
REPORT 1973-74. 1974. 147p.

Office of Coal Research
(Washington, D.C.)

Demand for energy continues upward in the U. S. and with shortages of natural gas and oil, coal must now be converted to pipeline and low-Btu quality gas, both liquid and solid fuels, and methods found to burn it cleanly to produce electricity. Programs for development of new technology to ensure the full utilization of coal without polluting the environment are described. Power generation systems for increasing the efficiency of thermal to electric energy conversion are described including MHD generators and components. Supporting projects sponsored by the OCR are described. International activities, administration, patents, committees, and legislative data are included. (MCW)

N74-19117# Bureau of Mines, Morgantown, W.Va. Energy
Research Center.
NONCAKING COAL GASIFIED IN A STIRRED-BED
PRODUCER Technical Progress Report
R. V. Raftusa, G. B. Goff, and A. J. Liberatore Mar. 1974
11 p refs

(BM-TPR-77) Avail: NTIS HC \$4.00

Noncaking O- by 2-inch subbituminous A coal from New Mexico was gasified with air and steam at 205 psig using a stirred-bed producer to determine coal losses by entrainment in the gas for this low sulfur, high ash coal which contained 20 percent particles smaller than 1/16-inch sieve size. The use of fine sized coal has particular importance because most production from mechanized mines is smaller than 2-inch size. This initial attempt showed technical feasibility for gasifying New Mexico subbituminous coal containing small sized particles in fixed-bed producers without excessive coal loss by entrainment. Dust loss averaged about 2 percent of moisture free coal, most of which was recovered from the gas. Ash clinkering was controlled by adding 1,010 lb/hr steam to reduce temperatures in the combustion zone. Yield of low-Btu fuel gas, 150 Btu per scf, dry, amounted to 69,800 scfh from 1,490 lb/hr coal (as received) and 3,450 lb/hr air (dry). Author

Dual Temperature Coal Solvation Process.

Willard E. Bull, Bruce Schmid, Charles H. Hinderliter,
Charles H. Wright, and Gerald R. Pastor.

Department of the Interior, Washington, D.C. Filed 4 Mar
74, 44p Docket/OCR-2144 Government-owned invention
available for licensing. Copy of application available NTIS.
PAT-APPL-446 971 PC\$5.25/MF\$1.45

The patent application describes a solvation process for producing deashed solid and liquid hydrocarbonaceous fuel from coal. Raw coal is slurried with a solvent comprising hydroaromatic compounds in contact with hydrogen in a first zone at a relatively high temperature to dissolve hydrocarbonaceous fuel from coal minerals by transfer of hydrogen from hydroaromatic solvent compounds to hydrocarbonaceous material in the coal. The solvent is then treated with hydrogen in a second zone at a lower temperature to replenish the solvent with hydrogen. Forced cooling of the slurry between zones accomplishes many significant improvements in the process.

Chemical Engineering Progress, v.70, no.6, June 1974, p.70-71.

Producing Clean Boiler Fuel from Coal

Preliminary design for a 10,000 ton/day plant for demonstrating a process that includes modified solvent refining and coal gasification.

J. B. O'Hara, N. E. Jentz, S. N. Rippee, and E. A. Mills
Ralph M. Parsons Co., Los Angeles, Calif.

Chemical Engineering Progress, v.70, no.6, June 1974, p.72-73.

A Pyrolysis Reactor For Coal Gasification

The flash pyrolysis technique and reactor design used to produce pipeline quality gas from sub-bituminous coals from Wyoming and Montana mines is described.

H. G. McMath, R. E. Lumpkin, J. R. Longanbach, and A. Sass
Garrett Research and Development Co., Inc., La Verne, Calif.

Chemical Engineering Progress, v.70, no.6, June 1974, p.74-75.

Coal Gasification by Pyrolysis

New process, soon to be installed in 250-ton/day demonstration scale plant, aims at lower capital costs as well as lower operating costs than other similar techniques.

D. E. Adam, S. Sack, and A. Sass

Garrett Research and Development Co., Inc., La Verne, Calif.

Chemical Engineering Progress, v.70, no.6, June 1974, p.76-82.

The Clean-Coke Process For Metallurgical Coke

Pollution problems, usual with conventional coke-oven technique, are not present in new carbonizing/hydrogenating method that will also produce a wide range of chemicals.

K. A. Schowalter and N. S. Boodman, U.S. Steel Corp., Monroeville, Pa.

TWO-STAGE GASIFICATION OF COAL WITH FORCED REACTANT MIXING AND STEAM TREATMENT OF RECYCLED CHAR. Donath, E. E. (to Secretary of the Interior). US Patent 3,782,913. 1 Jan 1974. Filed date 23 Mar 1972. 8p.

Methane-rich fuel gas is produced by a two-stage gasification process wherein particulate coal and steam are reacted in the second stage with synthesis gas from the first stage at temperatures in excess of 1600°F and pressures in excess of 50 atmospheres to produce char and a product gas containing hydrogen, methane and oxides of carbon. The char and product gas are withdrawn and separated and the product gas is thereafter treated to remove carbon oxides and other diluents and is ultimately methanated to produce a methane-rich fuel gas. The char is recycled to the first gasification stage for reaction with steam and oxygen at temperatures in excess of 2500°F and pressures in excess of 50 atmospheres to produce a synthesis gas containing hydrogen and oxides of carbon for reaction in the second gasification stage. A portion of the char, which has low-sulfur content, can be burned to produce process energy. Ash produced from the reactions in the first and second stages gravitates, at least partially as molten slag, to the lower sections of the reactor in stage one where the ash and slag are cooled and removed from the process. (MCW)

Coal Gasification. A Bibliography with Abstracts.

Edward J. Lehmann, and Kirk G. Werner.

National Technical Information Service, Springfield, Va.

May 74, 81p NTIS-WIN-74-038

COM-74-10967/9WN PCS20.00/MFS20.00

This bibliography contains 76 selected abstracts of research reports retrieved using the NTIS on-line search system-NTISearch. The topics included cover all aspects of coal gasification which concern the use of coal gas as a fuel or feedstock. Desulfurization of coal by gasification is not covered unless the use of the gas is discussed. Also presented are in situ combustion studies on removing coal from its deposits by underground gasification. (Author)

GAS-FROM-COAL: AN UPDATE.

N.P. Chohey.

Chemical Engineering, v.81, no.5, Mar.4, 1974, p.70-73.

What's happening in the realm of making gaseous fuels from coal: As the accompanying tables indicate, there has been a revitalization of established coal-gasification processes as well as an outpouring of new ones.

Science, v.184, no.4134, Apr.19, 1974.

Clean Fuels from Coal Gasification: A. M. Squires

340

GARRETT'S COAL PYROLYSIS PROCESS.

A. Sass.

Chem. Eng. Prog., v.70, no.1, Jan.1974, p.72-73.

Early development work indicated a maximum of 35% conversion of coal to liquid.
Pilot plant studies are now underway.

HYGAS PILOT YIELDS OPERATING DATA.

B.S. Lee, Inst. Gas Tech.

Oil & Gas Jour., Feb.11, 1974, 75, 76.

Integrated operation at design conditions has been achieved with the Hygas process pilot plant. For nearly a week, the plant produced 900-1,000 BTU/cu ft gas at a coal feed rate of 3-tons/hr.

1974

COAL GASIFICATION: AN ALTERNATIVE IN CLEAN ENERGY PRODUCTION. Goodholm, P. R. Combustion; 45: No. 9, 6-11(Mar 1974).

From petroleum mechanical engineering conference; Los Angeles, CA (16 Sep 1973).

The energy supply situation existing today in the U. S. is examined. The natural gas supply is short, but with the utilization of the one remaining abundant energy resource, coal, shortages may be alleviated. A coal gasification plant is proposed to be built in the Four Corners Area of New Mexico and is under design. The Lurgi process used to gasify the coal, to be mined in near-by New Mexico, Utah, Colorado, Wyoming, Montana, and North Dakota, is described. Technical, environmental, and economical aspects of the plant design are presented. (MCW)

UNDERGROUND GASIFICATION OF COAL.

R.M. Nadkarni, et al.

Chemtech, April 1974, p.230-237.

When the Bureau of Mines wanted an appraisal of 'retorting' in situ coal to gas, they asked Nadkarni, Bliss and Watson. This is what they learned.

THE GASIFICATION OF COAL.

Harry Perry.

A Scientific American, v.230, no.3, Mar.1974, p.19-25.

This formerly widespread technology, which lost its markets to natural gas and petroleum, is now being reexamined. New methods promise and alternative source of fossil-fuel energy.

METHANATION OF COAL GAS FOR SNG.

F.W. Moeller, et al.

Hydrocarbon Process, v.53, no.4, Apr.1974, p.69-74.

1974

Applicability of the Meyers Process for Chemical Desulfurization of Coal: Initial Survey of Fifteen Coals.

J. W. Hamersma, M. L. Kraft, C. A. Flegal, A. A. Lee, and R. A. Meyers.

TRW Systems Group, Redondo Beach, Calif. Apr 74, 20p
EPA-650/2-74-025
PB-232 083/6WE PC\$5.75/MF\$1.45

The report given detailed experimental results of applying chemical desulfurization technology to a variety of U.S. coals. Run-of-mine coal samples were collected from 15 U.S. coal mines in 11 states. Each coal was treated separately by the Meyers Process (ferric sulfate extraction) and float-sink fractionation (physical coal cleaning). The Meyers Process removed 83-99% of the pyritic sulfur (40-64% of the total sulfur) from all the coals that contained sufficient pyritic sulfur for accurate sulfur determination. The Meyers Process also removed significant amounts of selected trace elements along with the pyrite. Solvent extraction of organic sulfur was investigated. (Modified author abstract)

1974

An Interpretative Compilation of EPA Studies Related to Coal Quality and Cleanability.

L. Hoffman, J. B. Truett, and S. J. Aresco.

Mitre Corp., McLean, Va. May 74, 274p EPA-650/2-74-030
PB-232 011/7WE PC\$6.50/MF\$1.45

The report provides an interpretative compilation of the overall EPA coal cleaning effort in the form of in-depth analysis, evaluation, and examination of the inter-relationships among elements comprising the EPA coal program. The report basically addresses coal washability studies, sulfur reduction by cleaning processes including plant design and associated economics, and the utilization of reject sulfur and coal values from the cleaning processes.

252

PRODUCTION OF LOW-B.T.U. GAS FROM COAL IN COMBINATION WITH ADVANCED POWER CYCLES.

S. Dobner, M.J. Gluckman, and A.M. Squires.
Recent Advances in Air Pollution Control, AIChE Symposium Series, v.70, no.137, 1974, p.223-229.

Under Grant GI-34286 from the RANN Program ("Research Applied to National Needs") of the National Science Foundation, a team at The City College has begun "studies toward improved techniques for gasifying coal." Our primary objective is to study chemistries and unit operations that could be useful in a Coalplex for simultaneous production of pipeline gas, a light aromatic liquid fuel, and electricity (1). We are also undertaking flow sheet studies to identify commercial opportunities as quickly as possible and to guide our experimental work. This paper is our first report on results of flow sheet studies.

TWO-STAGE COAL COMBUSTION PROCESS (FOR SO₂ -FREE STACK GAS).

J.A. Karnavas, P.J. LaRosa, and E.A. Pelczarski.
Recent Advances in Air Pollution Control, AIChE Symposium Series, v.70, no.137, 1974, p.245-249.

With sulfur-bearing coal as their prime source of energy, electric utilities must modify coal burning techniques to eliminate sulfur dioxide pollution from existing and new power plants. For this reason, the Applied Technology Corporation is developing the Two-Stage Coal Combustion Process which prevents the oxidation of sulfur during coal combustion (under sponsorship of the Environmental Protection Agency's Office of Air Programs Contract No. CPA 70-146). In this process, coal is gasified in molten iron to produce a sulfur dioxide-free hot offgas suitable for combustion in conventional power plant boilers. The sulfur is first retained in the iron and then transferred to a slag, which is removed and desulfurized to produce elemental sulfur and a sulfur-free road building slag.

Experimental results using 0.6 to 3.5% sulfur coal have shown that an essentially SO₂ free offgas is generated. Operating costs are comparable to those of coal-fired SO₂ polluting plants. Capital requirements for a retrofitted installation are estimated to be \$23/KW for a 1,000 MW power station. Capital cost savings, realized when the process is incorporated into a new power plant, result in only \$1.5/KW increase in capital cost over a new coal-fired polluting plant.

STATUS OF LOW B.T.U. GAS AS A STRATEGY FOR POWER STATION EMISSION CONTROL.

J. Agosta, et al.

Recent Advances in Air Pollution Control, AIChE Symposium Series, v.70, no.137, 1974, p.217-222.

During recent years, the authors' company, one of the largest investor-owned utilities, has studied and implemented several strategies for the reduction of sulfur dioxide emissions from its utility boilers. These include among others switching to low-sulfur fuels and a greater reliance upon nuclear power. One recent area of interest is the processing of fuel prior to combustion, namely, through the total gasification of coal and processing suitable for combustion in present utility boilers.

Specifically, the authors will present their views on the production of a Producer gas of approximately 150 to 200 B.t.u. and its application to the present and future coal burning coal generating units.

PROCESS DEVELOPMENTS: FIXED-BED CATALYSIS OF COAL TO FUEL OIL.

P.M. Yavorsky, S. Akhtar, and S. Friedman.

Recent Advances in Air Pollution Control, AIChE Symposium Series, v.70, no.137, 1974, p.101-105.

Several advancements have been made in a novel process being developed for converting coals into clean fuel oil that has very low sulfur and ash contents. Coal conveyed in recycle oil is propelled by rapid, turbulent flow of hydrogen through a reactor packed with immobilized (fixed bed) catalyst pellets. In addition to three coals previously hydrosulfurized, a relatively low-value, high-sulfur Kentucky strip coal having 4.6% sulfur and 17% ash has been continuously converted in a small pilot plant into high-value fuel oil having only 0.19% sulfur and 1% ash. This oil more than satisfies air-quality standards for sulfur in fuels for electric power plants. Two recently demonstrated process improvements that reduce process cost are a four-fold reduction in gas flow through the reactor and a 50% increase in coal throughput (synthetic oil production). Also demonstrated were the feasibility of recycling unconsumed hydrogen, the effect of H₂ S contamination of the recycled gas, and the effect of presulfiding the catalyst silica-promoted cobalt molybdate).

COAL CONVERSION TECHNOLOGY.

H. Perry, Resources of the Future.
Chem. Engineering, v.81, no.15, July 22, 1974
p.88-102.

Years of experience with old routes,
and millions of dollars spent
investigating new ones, add up to
a lot of knowledge about converting
coal to liquid or gas products. Here's
a review of important processes
under consideration.

CLEAN CONVERSION OF COAL TO ELECTRIC

POWER: A DOLLAR AND CENTS APPROACH. Ashworth, R. A.;
Bolez, C. A. Pub. Util. Fortn.; 93: No. 6, 36-42(14 Mar 1974).

Direct combustion of coal in a conventional steam cycle with
stack gas cleanup; direct combustion of coal in conventional cycles
with fluid bed boilers; low Btu gas burned in conventional boilers
and conventional combined cycles; low Btu gas from coal used in
advanced combined cycles; and a coal extract residual fuel scheme
are methods discussed for the conversion of coal to electric power
in the near term. Costs of such technologies are examined and
the view is presented that full-scale financial and manpower in-
vestments by industry, government, and private investors are
necessary. (MCW)

COAL LIQUEFACTION PROCESS. Urban, P. (to
Universal Oil Products Co.). US Patent 3,796,850. 12 Mar 1974.
Filed date 24 Jul 1972. 10p.

A process is disclosed for de-ashing and liquefying coal that
comprises contacting comminuted coal with water, at least a
portion of which is in the liquid phase, a reducing gas and a com-
pound selected from ammonia and carbonates and hydroxides of
alkali metals, at liquefaction conditions, including a temperature
of 200 to 70°C. to provide a hydrocarbonaceous product. (Official
Gazette)

(UCRL-75494) IN-SITU COAL GASIFICATION. Ste-
phens, D. R. (California Univ., Livermore (USA). Lawrence
Livermore Lab.). 31 Jan 1974. 30p. (CONF-740118-1). Dep.
NTIS \$4.50.

From tri-state fossil fuels energy conference; Denver, Col-
orado, USA (31 Jan 1974).

Two approaches to in-situ coal gasification are reviewed. The
first is improvement of existing Russian technology, and the sec-
ond is development of a new method based on explosive fracturing.
The Russian techniques developed as early as 1935, generally in-
volved gasification of coal between boreholes by use of hydraulic
or air fracturing. These installations made a combustible gas of
the order of 100 Btu/scf, and this gas was primarily used for
electrical power generation. However, the product gas flow rate
fluctuated and the heating value generally decreased with time.
This made for inefficient power production, and the process was
not competitive with the oil and gas discoveries made in Russia
during the late 1950's. American experiments using Russian
techniques, were conducted by the U. S. Bureau of Mines during
the 50's in Gorgas, Alabama. They confirmed the Russian re-
sults. The Lawrence Livermore Laboratory concept for in-situ
coal gasification is to use chemical explosives in an array of
drilled holes to fracture coal at depths from 1000 to 2000 ft. The
top of the resulting permeable fractured area would be ignited
and then a steam-oxygen mixture would be continuously supplied
at 500 to 1000 psi pressure. In essence, the concept represents
an underground packed bed reactor. The coal in the fractured bed
would be gasified with steam and oxygen just as in conventional
high-Btu coal gasification. The gases produced underground should
consist primarily of methane, carbon monoxide, carbon dioxide,
and hydrogen, and they would be treated in a surface facility to
produce pipeline-quality gas. The projected selling price of the
gas ranges from 50 to 70¢/mcf (per million Btu). The upper
estimate, 70¢/mcf, is only two-thirds the projected cost of gas
produced by the modern United States surface coal gasification
processes now under development and is about half the cost of
gas from the existing Lurgi process. (auth)

COAL DISTILLATION - THE PRODUCTION OF FUEL GAS.

J. Falque.

Entropie, no.55, Jan./Feb.1974, p. 25-29.

(In French)

The conversion of coal to gaseous fuel is
not a new idea, but apart from the coke
ovens and gas works supplying towns,
genuine gasification processes have so far
led to very few developments, except in
special circumstances. The concern
about sulphur pollution from solid and
liquid fuels, and also the threat of an
energy shortage and higher petroleum
prices, have caused renewed attention to
be given to coal distillation. We will
consider in turn:
- the production of low calorific value
gas (1 to 3 megacalories/m³),
- the production of rich gases: high ca-
lorific value gas (3.5 to 5 megacalo-
ries/m³) and very high calorific value
gas (8 to 8.5 megacalories/m³).

AN ADVANCED COAL GASIFICATION SYSTEM FOR
ELECTRICAL POWER GENERATION.

S. Lemezis, J.C. Agarwal, and G.W. Land (West-
inghouse Electric Corp., Pittsburgh, Pa.)

Mining Congr. J., v.60, no.4, Apr.1974, p.22-7.

CLEAN FLUID FUELS FROM COAL AND WASTES.

Available without charge as 'OP-149-73'
from the Publications Distribution
Section, Bureau of Mines, 4800 Forbes
Ave., Pittsburgh, Pa. 15213.

CHEMICALS FROM COAL: BEST BET IN ENERGY CRISIS.

Chem. Week, v.114, no.34, June 1974, p.11-18.

(ORNL-TM-4370, pp 472-474) COAL CONVERSION

STUDIES. Ferris, L. M.; Bennett, M. R.; Thompson, C. T.
Feb 1974.

In Chemical Development Section B semiannual progress report,
March 1, 1973-August 31, 1973. Part I.

Studies of the conversion of coal to liquid and gaseous fuels
by catalyzed and pressurized hydrogenation have been initiated.
Preliminary studies have been made on the use of HF in the gas-
eous mixture to accelerate the hydrogenation process. HF concen-
trations up to 20 mole % did not have a favorable effect. (auth)

COAL TECHNOLOGY REPORT: Annual report
of the Office of Coal Research, U.S.
Department of Interior. Includes
descriptions of projects in progress
for converting coal to other energy
forms. 145 pages. (No. 2414-00075,
available at \$2.20 from Superintendent
of Documents, Government Printing
Office, Wash., D.C. 20402.)

~~ADVAN. CHEM. SER. 134 (1974)~~

~~PRODUCTION OF LOW BTU GAS INVOLVING COAL PYROLYSIS AND GASIFICATION. BY MEN, C.Y.~~

~~BAILIE, R.C. LIN, C.Y. O'BRIEN, M.S. P 9-28.~~

~~PRESSURIZED HYDROGASIFICATION OF RAW COAL IN A DILUTE PHASE REACTOR. BY FELDMAN, M.F.~~

~~MIMA, J.A. YAVORSKY, P.H. P 108-25.~~

~~CHEMISTRY AND PHYSICS AND ENTRAINED COAL GASIFICATION. BY ZAHRAONIK, R.L. GRACE, R.J. P 126-44.~~

~~CATALYSIS OF COAL GASIFICATION AT ELEVATED PRESSURE. BY HAYNES, M.P. GASTOR, S.J. FORNEY, A.J. P 179-202.~~

COM-73-11377/1 PC\$20.00/MF\$20.00
National Technical Information Service, Springfield, Va.

COAL GASIFICATION: A BIBLIOGRAPHY WITH ABSTRACTS.

Rept. for 1964-May 73.

Edward J. Lehmann. Jul 73, 52p* NTIS-WIN-73-013

Supersedes NTIS-PK-101.

Descriptors: (*Coal gasification, *Bibliographies), Manufactured gas, Desulfurization.
Identifiers: Low sulfur fuels, In situ combustion, NTIS-WIN-73-013.

The NTISearch bibliography contains 51 selected abstracts of research reports retrieved using the NTIS on-line search system-NTISearch. The topics included cover all aspects of coal gasification which concern the use of coal gas as a fuel or feedstock. Desulfurization of coal by gasification is not covered unless the use of the gas is discussed. Also presented are in situ combustion studies on removing coal from its deposits by underground gasification. (Author)

COM-73-11381/3 PC\$20.00/MF\$20.00

National Technical Information Service, Springfield, Va.

DESULFURIZATION OF COAL AND PETROLEUM: A BIBLIOGRAPHY.

Rept. for 1964-May 73.

Elizabeth A. Harrison. Jun 73, 76p* NTIS-WIN-73-017

Supersedes NTIS-PK-64, and NTIS-PK-125.

Descriptors: (*Desulfurization, *Bibliographies), (*Coal, Desulfurization), (*Fuel oils, Desulfurization), Petroleum.

Identifiers: Low sulfur fuels, NTIS-WIN-73-017.

The NTISearch bibliography contains 78 selected abstracts of research reports retrieved using the NTIS on-line search system-NTISearch. The abstracts are divided into two sections. The first contains 59 reports on all aspects of coal desulfurization whereas the second section contains 19 abstracts dealing with petroleum desulfurization. (Author)

FLASH PYROLYSIS OF COAL: EFFECT OF NITROGEN, ARGON, AND OTHER ATMOSPHERES IN INCREASING OLEFIN CONCENTRATION AND ITS SIGNIFICANCE ON THE MECHANISM OF COAL PYROLYSIS. Banerjee, N. N.; Murty, G. S.; Rao, H. S.; Lahiri, A. (Central Fuel Research Inst., Dhanbad, India). Fuel; 52: No. 3, 168-170(Jul 1973).

Samples of three Indian coals, of widely differing origin and rank, were subjected to flash pyrolysis at a temperature of about 1150°C for 30 sec in vacuo, and under atmospheres of nitrogen, argon, ammonia, and perdeuterobenzene. The gaseous products of the pyrolyses were analysed by ir and mass spectroscopy and are discussed relative to the possible mode of influence by the pyrolytic atmospheres. It would appear that the pyrolytic atmosphere is an important factor in determining the composition of the pyrolysis products; the influence of nitrogen, argon and perdeuterobenzene is a physical one, leading especially to higher yields of olefins. (auth)

N74-17190 Brigham Young Univ., Provo, Utah.
KINETICS OF COAL GASIFICATION IN A LOW PRESSURE, LOW RESIDENCE TIME, ENTRAINED FLOW REACTOR
Ph.D. Thesis

Chiang-Liu Chen 1973 192 p

Avail: Univ. Microfilms Order No. 73-31405

Experimental studies were made with a small entrained reactor in which the finely-ground coal entrained in carrier gas was rapidly mixed with oxidizing combustion gases. A maximum of 66.5 percent coal was gasified in 0.012 seconds. The char formation was an overall zero order while the acetylene decomposition was a second order reaction with a frequency factor of 4 times 10 to the 7th power and an activation energy of about 12 Kcal/mole. The residence time of less than 0.050 seconds is sufficient for hydrocarbon gas production. Higher residence time resulted in lower gasification because of partial decomposition of hydrocarbons to elementary carbon. Dissert. Abstr.

74V14597 1973 ISS:00 TP759.B43 665.772 LC-74-153121

A/BERKOWITZ, NORBERT; A/1923-

COAL ♦♦ GASIFICATION; ♦♦ A "STATE-OF-THE-ART" REVIEW (BY) N. BERKOWITZ.

ALBERTA RESEARCH; EDMONTON; III; 53 P. ILLU. 25 CM.

\$5.00 INFORMATION SERIES; 64 INCLUDES BIBLIOGRAPHICAL REFERENCES.

LC:COAL ♦♦ GASIFICATION. ♦♦

ADDED:RESEARCH COUNCIL OF ALBERTA. INFORMATION SERIES; 64.

MAIN-AUTH TRACE-SER♦CORP♦ CATLG BY-LC

/ / PUBL IN CANADA

N74-12159# Bureau of Mines, Morgantown, W.Va. Energy Research Center.
DIRECTIONAL PROPERTIES OF COAL AND THEIR UTILIZATION IN UNDERGROUND GASIFICATION EXPERIMENTS Technical Progress Report
 C. A. Komar, W. K. Overbey, Jr., and J. Pasini, III Nov. 1973

14 p refs
 (BM-TPR-73) Avail: NTIS HC \$3.00
 Renewed interest in the underground gasification of coal evolves from comprehensive studies of earth fracture systems that indicate that the movement of fluids can be controlled in the coalbed. In particular, directional property studies of natural microfracture occurrence, permeability, ultrasonic velocity, tensile strength, and orientation of intervals of inherent rock weakness, together with geologic structure setting and fracture trace analysis, can predict the gaseous flow paths in the coalbed. Having this information, the dominant direction in which gases generated and/or liberated by heat can be determined so that appropriate well patterns can be developed. Together with advances made in drilling technology that permit long horizontal holes to be drilled through the coal seams, tests can be conducted to determine whether directional control will permit devolatilization of the coalbed low-Btu gas suited for the generation of electricity. Author

(NTIS-WIN-73-13) COAL GASIFICATION. A Bibliography With Abstracts. Lehmann, E. J. (National Technical Information Service, Springfield, Va. (USA)). Jul 1973. 52p.
 This bibliography contains 51 selected abstracts of research reports retrieved using the NTIS on-line search system — NTISearch. The topics included cover all aspects of coal gasification that concern the use of coal gas as a fuel or feedstock. Desulfurization of coal by gasification is not covered unless the use of the gas is discussed. Also presented are in situ combustion studies on removing coal from its deposits by underground gasification. (auth)

CAPTURING CLEAN GAS AND OIL FROM COAL.

L. Lessing.
 Fortune, Nov. 1973, p.129-131, 210, 214, 216, 218.

To fully exploit its major energy reserve, the U.S. needs a crash engineering job comparable to building the atomic bomb.

N74-21697# Massachusetts Inst. of Tech., Cambridge. Energy Lab.
IMPACTS OF NEW ENERGY TECHNOLOGY, USING GENERALIZED INPUT-OUTPUT ANALYSIS Final Report
 James E. Just Feb. 1973 302 p refs
 (Grant NSF GI-32874)
 (PB-226139/4GA; MIT-EL-73-1) Avail: NTIS HC \$7.00 CSCL 21D

Comparative economic and environmental impacts of high and low BTU coal gasification and the gas turbine topping cycle during the 1980-85 time period were forecast. The forecast used a projected 1980 input-output table that was augmented by detailed air pollution coefficients and water, steel, and energy usage coefficients. Direct and indirect impacts of both investment in and operation of the new technologies were examined. Data was obtained from basic engineering studies of these processes and converted to input-output, technical and capital coefficients. Alternative high, medium, and low energy growth futures for 1985 were projected both with and without the new technologies. Results indicate the high sensitivity of total capital investment and certain capital goods industries to the rate of energy use growth. Aggravation of the situation may result from the introduction of high BTU coal gasification. Several economic mechanisms that will help to hold total capital investment within its historical boundaries as a percentage of GNP are also examined. Possible applications, refinements, and extensions are included. GRA

(PB-221406-2) CHEMICAL DESULFURIZATION OF COAL: REPORT OF BENCH-SCALE DEVELOPMENTS. Volume 2. Final Report. Hanerama, J. W.; Koutsoukos, E. P.; Kraft, M. L.; Meyers, R. A.; Ogle, G. J. (TRW Systems Group, Redondo Beach, Calif. (USA)). Feb 1973. Contract EHS-71-1. 86p. NTIS \$4.85.

Computer programs for analysis of leach processes, laboratory experimentation, and data tables are given for the Meyers process applied to the desulfurization of coal. (GRA)

CHEMICAL MINING OF COAL TO AVOID STRIPPING.
 Elliott, G. R. B. (Los Alamos Scientific Lab., NM). Environ. Lett.; 5: No. 1, 17-20(1973). (LA-DC-72-1502a).

If steam-oxygen mixtures replace the more customary air or oxygen feed gases for underground coal gasification, then the coal energy can be recovered with minimal environmental damage. Such chemical mining looks like an attractive alternative to strip mining. (auth)

COAL GASIFICATION: KELLOGG'S COAL GASIFICATION PROCESS. Cover, A. E.; Schreiner, W. C.; Skaperdas, G. T. (M. W. Kellogg Co., Houston, TX). Chem. Eng. Progr.: 69: No. 3, 31-36 (Mar 1973).

Gasification of coal in a bath of molten sodium carbonate through which steam is passed is the basis of the Kellogg Coal Gasification process. The bath of molten salt strongly catalyzes the basic steam-coal reaction permitting essentially complete gasification of coal at reduced temperature. The molten salt can be used to supply heat to the coal undergoing gasification. The molten bath serves to disperse coal and steam throughout the reactor, which permits direct gasification of caking coals and eliminates the need for carbonization of such coals. The bath of salt operates at a uniform temperature in the gasification range and, combined with the catalytic effect of sodium carbonate on steam-carbon gasification, yields a raw gas that is free of tars, tar acids, and tar bases. Gasification of coal in a single-vessel and conversion to pipeline gas requires substantial additional processing in addition to the gasification operation. The economics of the entire system is discussed. (MCW)

EVALUATING THE BI-GAS SNG PROCESS. Hegarty, W. P.; Moody, B. E. (Air Products and Chemicals, Inc., Allentown, PA). Chem. Eng. Progr.: 69: No. 3, 37-42 (Mar 1973).

The Bi-gas process (Bituminous Coal Research, Inc.) is described using Western Kentucky No. 11 coal. The production of 250 million std cu ft/day of SNG product would require 22,500 tons of raw coal. After rejection of 38 percent refuse, 13,900 tons remain, with 88 percent going to gasification and the remainder to auxiliary steam generation and coal drying. Flow sheets of coal reaction with steam and oxygen, the water gas shift conversion, the Rectisol acid gas process, and the methanation processes are shown. The economics of the BCR process are discussed. (MCW)

COAL GASIFICATION: THE COED PROCESS PLUS COAL GASIFICATION. Shearar, H. A. (American Oil Co., Whiting, IN). Chem. Eng. Progr.: 69: No. 3, 43-48 (Mar 1973).

A conceptual design and an economic study were conducted for a plant to produce 250 million std cu ft/day of pipeline gas, and about 27,000 bbl/day of synthetic crude oil, from coal. The plant utilizes the Char-Oil-Energy-Development (COED) coal pyrolysis process along with the M. W. Kellogg Co.'s molten salt process to gasify COED char. The process is based on multi-stage fluidized-bed pyrolysis of coal to produce oil, gas, and char. The oil is hydrogenated to produce a synthetic crude oil, and the gas can be further processed to produce pipeline gas or hydrogen. The char, amounting to about half of the original coal feed, must be utilized efficiently to avoid a serious economic disability to the process. Possible uses for the char include burning as a boiler fuel for power generation or gasification to produce fuel gas. This design utilizes an existing process to gasify the char and to produce high Btu pipeline gas from the combined raw COED and gasification gases. (auth)

COAL GASIFICATION: THE TORCOAL PROCESS FOR LOW-TEMPERATURE COAL PYROLYSIS. Carlson, F. B.; Har-dumian, L. H.; Atwood, M. T. (Oil Shale Corp., Colden, CO). Chem. Eng. Progr.: 69: No. 3, 50 (Mar 1973).

In the TORCOAL process, shale or coal is heated and conveyed up the lift pipe by co-current flow with hot flue gas from the ball heater. The partially heated feed is then heated to carbonization temperature by direct contact with heated ceramic balls in a rotating drum retort. Heat transfer rates within the retort are high, thus making very high throughput rates possible. The solid carbonization residue is separated from the heat-carrier balls using a trommel screen positioned at the discharge end of the retort. The hot residue is cooled in a rotary tube cooler using residue sensible heat to generate steam. The heat carrier balls are cycled back to the ball heater for reheating prior to another pass through the retort. Vapor from the retort is cooled to condense and remove tar and water from the gaseous components of the stream. The yield of products from the subbituminous coal from Gillette, Wyoming, retorted at temperatures from 800 to 970°F, are given. (MCW)

COAL GASIFICATION: SCALE-UP FACTORS IN THE H COAL PROCESS. Johnson, C. A.; Chervenak, M. C.; Johnson, E. S.; Wolk, R. H. (Hydrocarbon Research, Inc., Trenton, NJ). Chem. Eng. Progr.: 69: No. 3, 52-54 (Mar 1973).

Some data on scale-up obtained at Hydrocarbon Research, Inc. on the commercialization of the H-Coal process are discussed. Development on the process was conducted on bench-scale and process development units. The bench units use reactors about 3.4 in. dia and handle about 25 lbs coal per day. The process development unit (PDU) reactor is 8 1/2 in. dia and handles 2.5 tons/day of coal feed, a scale-up factor of about 200. The next unit will be a prototype with a 4.5 ft dia reactor with a scale-up factor of 100 from the process unit. The commercial-size reactors will be a scale-up of 10 from the prototype. (MCW)

COAL GASIFICATION: TWO-STAGE COAL COMBUSTION PROCESS. Karnavas, J. A.; LaRosa, P. J.; Pelczarski, E. A. (Applied Technology Corp., Pittsburgh). Chem. Eng. Progr.: 69: No. 3, 54-55 (Mar 1973).

The strong affinity that exists between iron and sulfur, which makes it difficult to produce low-sulfur iron and steel, is the basis of the new gasification process. Coal is dissolved in a mass of molten iron where the coal's fixed carbon and sulfur are retained, and the coal volatilizes crack and exit in the offgas as carbon monoxide and hydrogen. The dissolved carbon in the iron is then gasified by reaction with combustion air to yield additional carbon monoxide to the offgas. Experimental results show that an essentially SO₂-free offgas for subsequent combustion in a power plant boiler is produced. Based on anticipated gasification rates and experimental coal solubility efficiencies, the Two-Stage Coal Combustion process yields electrical power operating costs comparable to existing plants without SO₂ pollution into the atmosphere. (MCW)

COAL GASIFICATION: LOW B.T.U. GAS FOR POWER STATION EMISSION CONTROL. Agosta, J.; Illian, H. F.; Lindberg, R. M.; Tranby, O. G. (Commonwealth Edison Co., Chicago). Chem. Eng. Progr.; 69: No. 3, 65-66(Mar 1973).

It is shown that, as a fuel supply, low-Btu gas possesses several advantages over stack gas scrubbing. The low-Btu gas supply using the pressure gasifier can generate a net excess of electric power through the use of an unfired expander turbine; this contrasts with the stack gas emission process which has a parasitic drain of from

5 to 10% of the power generated. Secondly, the gas purification processing in the gas supply system works to remove H_2S for which technology exists, instead of SO_2 , and it has to work on less than 5% of the volume of the gases that would be processed in a stack-gas-scrubbing system. This process has lower capital requirements, a lower operating cost, and higher energy recovery efficiency. Direct integration with a power plant will permit the recovery of a portion of the sensible heat and an 80% overall efficiency of the gasification plant is expected. A major objective of this project is to clarify and develop the ability to operate a gasifier, desulfurizer, clean-up system through the stringent requirements of turndown, shutdown, and startup of the utility mid-range or peaking unit. (MCW)

COAL GASIFICATION: HOW BEST, HOW SOON. Chem. Eng. News; 51: No. 46, 18-19(12 Nov 1973).

The six processes now being considered in the development program sponsored by the Office of Coal Research and the American Gas Association are discussed briefly, and the present status of each is revealed. The two most advanced, the Lurgi in Westfield, Scotland (see Chem. Eng. News, Nov. 5, 1973) and the Hygas in Chicago, have operated in pilot-plant stages. Trials on the first of four types of coal in the former have been completed, but disclosure of results will await completion of tests on the other three in the Spring of 1974. The Hygas plant, operating on Montana lignite (22 tests, 2000 tons) has produced pipeline-quality gas with a heating value of ~1000 Btu/s.c.f. Most of the other processes will be entering the pilot stages within the next 18 months, and an evaluation of all pilot-plant results will likely determine the future of the gasification industry's character. The most optimistic projections indicate that the first commercial plant could be built by 1978, but most observers believe that no significant quantities of synthetic pipeline gas will be available before 1985. (LMT)

OCCIDENTAL DEVELOPS LOW-COST SNG ROUTE.

Chem. Eng. News; 51: No. 51, 23-24(17 Dec 1973).

A subsidiary of Occidental Petroleum Co., Garrett R & D Co., along with Colorado Interstate Gas Co., has developed a low-pressure pyrolysis system for the development of producing pipeline gas from coal. The Garrett process is based on the concept of partial gasification of coal in which the optimum yield of methane and other hydrocarbons is obtained by rapid pyrolysis of pulverized coal. The method eliminates the need for either an inert heating medium or an auxiliary oxygen plant. The Garrett process is perhaps suitable for integration with a large power plant. Assuming that the present development schedule continues, Garrett expects to go on stream with a commercial plant within six years. (MCW)

COAL GASIFICATION: CONVERTING COAL INTO

NONPOLLUTING FUEL OIL. Yavorsky, P. M.; Akhtar, S.; Feldman, S. (Bureau of Mines, Pittsburgh). Chem. Eng. Progr.; 69: No. 3, 51-52(Mar 1973).

A novel process for converting coals into nonpolluting fuel oils that have very low sulfur and ash contents is described. Coals with high sulfur content can be used. The one-step desulfurization process uses rapid, turbulent, flow of hydrogen to propel coal slurry through an immobilized bed of catalyst pellets in a reactor of its own product oil. The combined effect of the hydrogen, high yields, and high throughput. Sulfur is removed at H_2S that is easily converted to inert elemental sulfur for industry or storage. Results are presented for a low-value strip-mine coal from Kentucky, having a high sulfur content of 4.6 percent and an ash content of 17 percent. (MCW)

COAL GASIFICATION: A FLUIDIZED-BED COMBUSTION SYSTEM. Fraas, A. P. (Oak Ridge National Lab., TN). Chem. Eng. Progr.; 69: No. 3, 58-59(Mar 1973).

A fluidized-bed combustion chamber for coal is coupled to a potassium steam cycle to provide low fuel costs and reduce sulfur oxide emissions from relatively high sulfur coal. Such a system shows promise of giving an overall thermal efficiency of over 50%, thus reducing the fuel consumption by about 25%, and reducing the waste heat rejection to about half of that from the best current coal-fired steam plants. The system is described and the economics of the system is studied. (MCW)

COAL GASIFICATION: DESIGN OF A COAL-OIL-GAS REFINERY. Frank, M. E. (Chem Systems, Inc., New York); Schmid, B. K. Chem. Eng. Progr.; 69: No. 3, 62-64(Mar 1973).

The COG refinery complex, combining several processes currently being developed, shows considerable economic promise for production of high Btu pipeline gas, a liquid feedstock for a petroleum refinery, and a low sulfur fuel for power plants. A significant feature of this type of process complex is that most of pipeline gas consists of methane recovered from the individual processing steps without requiring methanation of synthesis gas produced in the gasification step. (auth)

(NP-19946) SELECTION OF COALS FOR THE AVCO HYDROGEN PLASMA ARC PROCESS FOR MAKING ACETYLENE. Research and Development Report No. 61, Interim Report No. 5. Given, P. H. (Pennsylvania State Univ., University Park (USA)). Dept. of Materials Science). 1 Mar 1973. Contract 14-01-0001-390. 13p. GPO \$0.50.

A set of 30 samples of coals from different regions of the U. S. and of various ranks were selected from the Penn State sample collection and tested by AVCO for acetylene production. It was found that the most effective coals are the high volatile bituminous, the yield falling off with either medium volatile bituminous or subbituminous. Since the high volatile bituminous class is a large one and there was an appreciable range of yields within it, attempts were made to identify the most effective coals more specifically. Within the class no clear correlations could be found with such parameters as volatile matter, hydrogen content, or reflectance, nor with empirical combinations of these, though there does appear to be a somewhat greater probability of obtaining good acetylene yields if the reflectance is at the lower end of the range for highly volatile bituminous coals. There are indications that western coals tend to have more hydrogen in relation to their carbon than other coals, but there was no evidence that this increased the acetylene yield. Examination of the solid by-product of the processing of these coals suggested that the coal feed had been nonuniformly exposed to the high-temperature reducing conditions. It was thought that differences in acetylene yield might reflect accidental differences in processing conditions rather than true differences in the organic substance of the coals. Accordingly, the results were not reported, and a fresh set of 30 samples was submitted for testing under modified conditions that should ensure uniform exposure of the feed. (MCW)

(NP-19947) REMOVAL OF SULFUR FROM COAL BY TREATMENT WITH HYDROGEN. Phase 1. The Effect of Operating Variables and Raw Material Properties. Research

and Development Report No. 77, Interim Report No. 1. Cary, J. H.; Baldwin, R. M.; Bao, C. Y.; Kirchner, M.; Golden, J. O. (Colorado School of Mines, Golden (USA)). 30 May 1973. Contract 14-02-0001-1225. 108p.

The purpose of this investigation was to determine which process variables had a significant effect on the desulfurization of coal by hydrogen treatment at reaction temperatures of 325 and 400°C; pressures of 800 and 1200 psig; reaction times of 7.5 and 15 min; solvents of anthracene and tetralin; and solvent-to-coal ratios of 3/1 and 4.5/1. A coal-solvent slurry was reacted with hydrogen at elevated temperatures and pressures in a batch autoclave rocking bomb reactor. Four different raw coals (two bituminous and two sub-bituminous) were tested. Both solvent type and temperature were found to be very highly significant variables (99% confidence level) in the solvent refining process for the desulfurization of coal. Some significance (90% confidence level) of the solvent-to-coal ratio was demonstrated for the sub-bituminous coals. Anthracene oil was found to be a better solvent for the process than tetralin since the dissolution of the coal in the anthracene was greater and the hydrogen transfer characteristics appeared to be better in comparison to the tetralin. The tetralin solvent was totally recoverable from the solvent-refined product, while the anthracene oil was only partially recoverable (50 to 80%) since the coal was only partially depolymerized under reaction conditions investigated. Inorganic sulfur was easily removed from the raw coal by the solvent-refining technique (98%) while organic sulfur was removed to a lesser degree (81%). The degree of dissolution and depolymerization of the coal in the solvent was an important process factor for overall desulfurization. (MCW)

TITLE: Degasification of Coalbeds: A Commercial Source of Pipeline Gas
AUTHOR: Deul, M.; Pfields, R.R.; Elder, C.H.
CORPORATE AUTHOR: U.S. Dept. of Interior, Bureau of Mines

ADDRESS: Pittsburgh, PA 15213
PUBLICATION DESCRIPTION: Paper presented at Clean Fuels from Coal Symposium, September 10 - 12, 1973, 9 p.

PUBLICATION DATE: 1973, September
SPONSOR: Institute of Gas Technology
ABSTRACT: A byproduct of intensive research conducted by the Interior Department's Bureau of Mines on degasification of coalbeds for improved mine safety is evidence that commercial quantities of pipeline quality natural gas can be produced. Coalbed degasification by draining gas from the coalbed before it is mined can be accomplished by drilling vertical holes into virgin coalbed areas from small hydrofracturing; by drilling horizontal holes specially designed boreholes; or using drainage holes from large ventilation shafts sunk to the coalbed in advance of mining. It is estimated that the minable coalbeds of the conterminous United States that are less than 3,000 feet deep may contain 260 trillion cubic feet of natural gas. The pertinent coalbed properties are discussed and results of a novel drilling method are presented. (Auth)

AVAILABILITY: Institute of Gas Technology, 3628 S State St., Chicago, IL 60616

(PB-221405-4) CHEMICAL DESULFURIZATION OF COAL: REPORT OF BENCH-SCALE DEVELOPMENTS. Volume 1. Final Report. Hamersma, J. W.; Koutsoukos, E. P.; Kraft, M. L.; Meyers, R. A.; Ogle, G. J. (TRW Systems Group, Redondo Beach, Calif. (USA)). Feb 1973. Contract EHS-71-7. 184p. NTIS \$6.00.

Bench-scale and laboratory tests were conducted for chemical removal of sulfur (S) from coal to produce a low sulfur coal to meet air quality standards. The method used was the Meyer's process in which pyritic sulfur is oxidized by ferric compounds to a water soluble form. Approximately 100% of pyritic S was removed, using aqueous ferric salt solutions which, for the four coals tested, corresponded to an absolute removal of 1 to 3.5% by coal weight of S. The heat content of the coal increased and the ash content decreased as a result of pyrite removal. The pyritic S was removed from the coal as elemental S (40 mole %) and iron sulfate (60 mole %). Process operating temperatures of 50 to 130°C, pressure of 1 to 10 atm, residence times of 1 to 16 hrs, and coal top sizes from 1/4-in. to 100 mesh were evaluated. Preliminary process design and cost estimation for a 100-ton/hr coal desulfurization plant are given. (GRA)

PIPELINE GAS FROM CRUDE OIL. Heubler, J.; Janka, J.; Seay, G.; Tarman, P. (Inst. of Gas Tech., Chicago). Chem. Eng. Progr.; 69: No. 5, 91-93 (May 1973).

The Institute of Gas Technology's approach to the problem of carbon deposition is to eliminate the carbon-forming materials by hydrocracking the heavy oil prior to hydrogenation. The continuous two-step process was described in which low-grade crude and residual oils can be converted to pipeline gas and low-sulfur fuel oil. The feed oil is hydrocracked catalytically, and the resulting product is fractionated. The lightest fraction, containing no carbon-forming materials, is hydrogenated non-catalytically to make the gas product. The heavier fractions are used for process fuel and hydrogen production by partial oxidation. The amount of low-sulfur fuel oil produced can be varied by adjusting the capacity of the hydrocracking unit. An accounting procedure was used to compare the cost of gas from SNG plants to evaluate the plant revenue requirements for a 250×10^6 Btu/day installation. (MCW)

COAL GASIFICATION COMBINED PLANTS NEED PERSISTENT ENGINEERING, FEW MIRACLES.

Energy Digest, Apr.30,1973, v.3, no.8, Apr.30,1973, p.198-203.

CLEAN FLUID FUELS FROM COAL AND WASTES.

A.J. Forney and W.P. Haynes.
Jour. Engineering for Power, July 1973, p.142-144.

OPTIMIZING THE CLEAN ENERGY REFINERY.

Heat Eng.; 46: No. 3, 33-37 (1973).
The Process Plants Division of Foster Wheeler constructed a general computer model of a clean energy refinery that produces no products other than low-sulfur gaseous and liquid fuels that can be used in conformance with all government standards regarding the combustion of fuels in industrial and residential services. The REPOF complete linear programming system has the capability of setting up and optimizing any petroleum or petrochemical processing complex. A schematic block diagram is shown of the model using the effects of crude and SNG prices on the economics of a hypothetical 150,000 bpsd facility. (MCW)

SNG REFINERY CONFIGURATIONS. Hazellon, J. P.; Tennyson, R. N. (Flour Engineers and Constructors, Inc., Los Angeles). Chem. Eng. Progr.; 69: No. 7, 97-101 (Jul 1973).

Three SNG refinery configurations are evaluated according to their advantages, limitations, and economics to manufacture synthetic natural gas. Residuum hydroaulfurization, flexoloking, and partial oxidation configurations are considered. The common aspects of these refinery schemes are that (1) naphtha and lighter materials are deaulfurized and gasified to produce pipeline quality gas, and (2) the gas-oil cuts are hydro-cracked and/or cat cracked to naphtha and lighter materials for conversion to SNG, deaulfurized for the production of low sulfur fuel oil, or split for fuel processing. The primary differences among these refinery schemes are in the processing units chosen to treat residuum fractions. Costs of SNG from crude oil feedstock depends upon feed cost and properties, product mix and specifications, capacity, site location, financing, and many other factors. (MCW)

GOVERNMENT, PRIVATE GROUPS SEEK EFFICIENT COAL-TO-GAS SCHEME.

Cryogenics & Industrial Cases, Jan./Feb.1973, p.33,34.

Industrial gas producers are keeping a watchful eye on coal gasification developments.

COAL GASIFICATION PLANT BEGINS OPERATION.

Chem. Eng. News; 51: No. 45, 21 (5 Nov 1973).
The first commercial demonstration plant for converting coal to synthetic natural gas has begun operation at Westfield, Scotland, and is producing high calorific gas at a daily rate of 2.5 million ft³ and at a cost estimated at 70 to 90 cents per million Btu of gas. At Westfield, too, is a separate study to see whether a variety of coals from different areas in the U. S. can be gasified with equal success in a Lurgi gasifier. A new market would open up for the vast coal reserves in the U. S., estimated to last for the next 500 years, if the commercially and technically viable process of converting coal to methane is successful. The demonstration unit at Westfield proves for the first time that the methanation can be carried out in a continuous operation using gas generated from a commercial grade of coal. Eastern and mid-western U. S. coal has been unacceptable in a Lurgi-type gasifier due to caking and swelling, but it is hoped that by changing the parameters of the operation, the coals can be made to gasify satisfactorily. Construction of large-scale commercial units in the U. S. capable of producing as much as 250 million ft³ a day of the coal-derived natural gas would then be foreseeable. (MCW)

OBTAINING FUELS AND CHEMICAL PRODUCTS FROM

MIXTURES OF COAL AND OIL. Krichko, A. A.; Yulin, M. K. Khim. Tverd. Topl.; No. 6, 75-80(1973). (In Russian).

A theoretical scheme was developed for obtaining commercial products from distillates with a boiling point to 320°C from the liquid-phase hydrogenation product of a mixture of coal and oil. The scheme includes the isolation of C₇-C₈ phenols from the fraction with a boiling point to 240°C hydrofining distillates with a boiling point to 320°C, reforming gasolines, and hydrocracking of distillates with a boiling point of 180 to 320°C. When refining the hydrogenation product it is possible to obtain the following compounds: 3.4% phenols, 81.2% gasoline, 13.5% hydrocarbon gases C₁-C₄, 0.5% ammonia, 0.5% hydrogen sulfide, and 1.0% water. Data are tabulated characterizing the hydrogenation product from a 1:1 mixture of coal and oil, the results of hydrofining distillate with a boiling point to 320°C, the characteristics of the raw material and recycle for hydrocracking, the results of catalytic reforming of hydrofined gasoline, the results of hydrocracking the fraction with a boiling point of 180 to 320°C, and the characteristics of hydrocracked gasolines. (MPS)

(NP-19963) CLEAN ENERGY FROM COAL: A NATIONAL PRIORITY. 1973 Annual Report, Calendar Year 1972. (Department of the Interior, Washington, D. C. (USA)). 1973. 124p. GPO \$2.35.

The discussions consider energy to include fuel for heating, industrial processes, buildings, and homes; fuel for railroads, aircraft, and automobiles; and all uses of electricity that for the next 30 years will be generated substantially through burning fossil fuels. Environmental factors as they relate to the provision of clean energy fuels are discussed. New improved mining technology is necessary. The research programs being carried out by the OCR include pipeline quality gas; low-Btu fuel gas and electric power generation; and low-sulfur liquid fuels. The supporting research projects and their locations are presented. Some administrative, committee, patent, index, and report number data are included. (MCW)

CHEMICALLY MINING COAL. Elliott, G. R. B. (Los Alamos Scientific Lab., NM). Mining Eng. (N.Y.); v9(Sep 1973). (LA-DC-72-15026).

Some reactions with coal give off heat and others absorb heat. The reactions of coal with oxygen or air give off heat, but the reactions of coal with steam or with carbon dioxide absorb heat. By balancing the proportions of the two types of reactions, the energy of the coal can be almost completely recovered and environmental damage is minimized. The chemical reactions of solid coal + gaseous oxygen yields carbon dioxide. An in-depth table lists the thermodynamic values for reactions in coal processing beginning with the aforementioned reaction. Twelve reactions are tabulated. Areas of the Southern Rockies overlying coal fields are shown. Political pressures are heavy against stack emissions from coal fires. The Four Corners coal-burning power plant is involved in expensive stack emission control. Underground gasification plus available cleanup procedures could eliminate the particulate problem and reduce the sulfur problem before the power plant burned the fuel. (MCW)

CLEAN ENERGY FROM COAL TECHNOLOGY. Washington, DC; Department of the Interior (1973). 43p. GPO \$0.75.

The United States, with 6% of the world's population, consumes about 33% of its commercial energy supply. The demand for all fossil fuels combined is expected to double by 2000. Coal will be expected to play an important role to meet this need to reduce the requirements for imported supplies of gas and oil. The conversion of massive coal reserves to clean-burning pipeline gas is discussed. Research sponsored by the Interior's Office of Coal Research is discussed for high-Btu pipeline gas technology and pilot plants on the HYGAS (fluid bed), CO₂ acceptor, BI-GAS (entrained bed), and SYNTHANE (fluid bed) processes. The low-Btu fuel gas processes being investigated include the fluidized-bed gasifier and the entrained-bed gasifier. The low-sulfur fuel oil processes include extract hydrogenation, ebullated-bed hydrogenation, fixed-bed hydrogenation, and carbomization. The solvent refined coal method of extraction is described. (MCW)

TITLE: Char oil Energy Development, Period of Operation July 1971 - June 1972
AUTHOR: Jones, J.F.; Schoemann, F.H.; Haashar, J.A.; McNabb, R.D.; Scotti, L.J.; Eddingr, R.T.
CORPORATE AUTHOR: PNC Corp., Chemical Research and Development Center
ADDRESS: Princeton, NJ 08540
PUBLICATION DESCRIPTION: R&D Report No. 73, 113 p.
PUBLICATION DATE: 1973 (?)
SPONSOR: U.S. Dept. of Interior, Office of Coal Research

ABSTRACT: The COED process is being developed by the PNC Corporation under contract to the office of Coal Research, U.S. Department of the Interior. The process is the multi-stage fluidized-bed pyrolysis of high-volatile bituminous coals to produce oil, gas, and char. Catalytic hydrotreating of the oil yields a high-value synthetic crude oil suitable as a petroleum refinery feedstock. The product gas can be reformed to hydrogen or pipeline gas. The char product can be utilized as a boiler fuel for power generation or, alternatively, as a feedstock for gasification and reforming to pipeline gas. The work reported herein was carried out under Contract No. 14-32-0001-1212. The purpose of this work is to obtain engineering data for the design of a commercial plant. The data is to be obtained from operation of the COED pilot plant with several commercially important coals. (Auth, from Summary)

AVAILABILITY: GPO, Stock No. 2414-00053 (\$1.25)

1973

TITLE: A Kentucky Coal Utilization Research Program, Summary of First Year Progress and Accomplishments
CORPORATE AUTHOR: University of Kentucky, College of Engineering, Institute for Mining and Minerals Research

ADDRESS: Lexington, KY 40508

PUBLICATION DESCRIPTION: Annual report, 6 p.

PUBLICATION DATE: 1973, October

ABSTRACT: A research program is proposed which focuses on the cost controlling processing stages in the liquefaction of coal. These stages include the hydrogen supply, the separation of ash solids from coal oil, and catalysts for the solvation-hydrogenation approach to coal liquefaction; and reactor design and char utilization for the pyrolysis approach. Innovation research in these areas has the potential to provide a substantial improvement in the economics of large-scale coal liquefaction. A technical and economic systems study will define the advantages, disadvantages, and actual feasibility of the various methods of hydrogen production. The sensitivity of economic improvement to the pertinent independent variables will be established, both for thermochemical and electrolytic processes. (auth)

AVAILABILITY: ORES Publications, College of Engineering, University of Kentucky, Lexington, KY 40506

1973

TITLE: A Kentucky Coal Utilization Research Program, Project 2 - Gasification and Liquefaction of Kentucky Coal
CORPORATE AUTHOR: University of Kentucky, College of Engineering, Institute for Mining and Minerals Research

ADDRESS: Lexington, KY 40508

PUBLICATION DESCRIPTION: Annual report, July 1, 1972 - June 30, 1973, 70 p., 32 references

PUBLICATION DATE: 1973, September 30

ABSTRACT: The first part of this project was a technical and economic assessment of the status of the various methods to gasify and liquify coal. The results of a computer simulation of a very general gasification model have been presented in the previous quarterly reports. In this report descriptive summaries of the important processes either in the pilot or bench scale stage of development are given. Flow sheets and operating conditions, when available are tabulated. ---The second phase of this project was an assessment of non-process considerations which will effect the economics and development schedule of gasification and liquefaction processes. Factors such as air and water pollution requirements, labor availability, transportation, and market location were included. (auth)

AVAILABILITY: ORES Publications, College of Engineering, University of Kentucky, Lexington, KY 40506

1973

TITLE: A Kentucky Coal Utilization Research Program, Project 3 - Low BTU Gas and Solid Desulfurized Fuel
CORPORATE AUTHOR: University of Kentucky, College of Engineering, Institute for Mining and Minerals Research

ADDRESS: Lexington, KY 40508

PUBLICATION DESCRIPTION: Annual report, July 1, 1972 - June 30, 1973, 123 p.

PUBLICATION DATE: 1973, November

ABSTRACT: The primary goal in the first year was the evaluation of producer gas processes and processes to produce a solid desulfurized fuel at the lowest cost per Btu and per MWhr. We went to great length evaluating and modeling processes but it became apparent in the last five months that the price of energy from the so-called environmentally clean fuels will continue to rise at this historically unprecedented rate in this energy intensive world so that nearly all coal conversion processes, especially the low Btu producers, will become economical; or we will be able to produce oil and gas from coal and oil shale cheaper than we can buy it in the world market. We estimate that most processes will become economical before the technology has been fully demonstrated in a so-called commercial or demonstration plant. In our evaluation of producer gas processes we found that the fixed bed atmosphere gas producer (such as the Wellman Galusha) has the lowest fuel cost of the presently available processes. This cost is in the range of \$0.60 to \$0.85/MWhr. The same cost will ultimately be achieved by an atmospheric gas producer with an extended fire zone for two step gasification) or by a pressurized entrained gasifier. (Auth, from Summary)

AVAILABILITY: ORES Publications, College of Engineering, University of Kentucky, Lexington, KY 40506

UNCATALYZED HYDROGENATION OF COAL. Lieberberg, B. J.; Potgieter, H. G. J. (Univ. of Potchefstroom, S. Afr.). Fuel; 52: No. 2, 130-133(Apr 1973).

The uncatalyzed hydrogenation of a bituminous coal in a batch reactor with tetralin as solvent has been investigated. This investigation differs from others reported in the literature mainly in the sampling methods employed. Because of the methods previously employed, effects of heating to reaction temperature and cooling to ambient conditions were not excluded; this complicated an investigation into the kinetics of coal hydrogenation. Samples were withdrawn from the reactor after reaction temperature and pressure were reached. It is concluded that simple series or parallel reactions suggested in the literature for the hydrogenation of coal are oversimplified mechanisms. (auth)

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1973

POLLUTION-FREE FUELS. Leas, L. E.; Leas, R. L.; Johnson, C. J. (to Leas Brothers Development Corp.). US Patent 3,769,197. 30 Oct 1973. Filed date 9 Jul 1971. 8p.

The invention relates to the production of fuels from coal and more particularly to the production of desulfurized and pollution-free fuels. It is desirable from an economical standpoint to use coal for producing both liquid and gaseous fuels since coal is relatively inexpensive compared to petroleum crude oil, and is quite abundant in contrast to the rapidly dwindling domestic supply of the petroleum natural resource. One of the biggest drawbacks in using coal as a source for gasoline, or the like, or for gaseous fuels, is its high sulfur content. This problem is of even greater significance today where much emphasis is being placed on improving the environment by reducing air pollution. It is an objective of the invention to provide a process for producing sulfur-free liquid and gaseous fuels from coal in a unitary process. (MCW)

COAL GASIFICATION FOR ELECTRIC POWER GENERATION.

S. Lemezis and D.H. Archer.

Westinghouse Engineer, v.33, no.4, July 1973, p.119-126.

The ultimate goal of the coal-gasification power system project is the demonstration on a commercial scale of an economic and environmentally acceptable electric generating plant that links a coal-gasification system with a combined-cycle plant adapted for burning low-Btu fuel gas. The development of a small-scale fluidized-bed gasifier is underway, and then the conceptual gasification process will be chosen for final scale-up to prototype size. The research program and its financing are discussed. The time schedules for progress made and the projections into 1981 are presented. (MCW)

METHOD FOR FEEDING DRY COAL TO SUPERAT-

MOSPHERIC PRESSURE. Hoffer, F. D.; Soiler, H. H. (to Hydrocarbon Research, Inc.). US Patent 3,775,071. 27 Nov 1973. Filed date 20 Jul 1971. 4p.

A method for continuous feeding of dry coal particles from essentially atmospheric pressure to the superatmospheric pressure level of a coal gasifier or coal liquefaction reactor is achieved by a series of screw feeding devices each partially boosting the pressure level of the coal in stages to provide the dry coal at reactor pressure. (Official Gazette)

KINETICS OF CONVERSION OF TETRALIN DURING HYDROGENATION OF COAL.

Pogteter, H. G. J. (Univ. of Potchefstroom, S. Afr.). Fuel; 52: No. 2, 134-137 (Apr 1973).

Tetralin has been considered a reasonably good hydrogen donor for the hydrogenation of coal, but in the literature little attention has been given to the kinetics of its conversion. In this paper it is suggested that the conversion of tetralin, mainly to naphthalene, may be either a reversible or a non-reversible reaction depending on the catalyst employed. It is further concluded that stannous chloride, though considered one of the best coal hydrogenation catalysts, is inferior to cobalt oxide when the side reaction tetralin → decahydronaphthalenes and the rate of dehydrogenation of tetralin are considered. (auth)

ASSESSMENT OF FLUIDIZED-BED OIL GASIFICATION

FOR POWER GENERATION. Newby, R. A.; Keairns, D. L.; Archer, D. H. (Westinghouse Research Corp., Pittsburgh). J. Air Pollut. Contr. Ass.; 23: No. 1, 23-29 (Jan 1973).

Fluidized-bed gasification of high-sulfur oil at atmospheric pressure for the production of a clean fuel gas was evaluated technically and economically. The clean fuel gas was evaluated sulfur and particulates is utilized for power generation in conventional fossil-fuel-fired boilers. The gasification occurs in a limestone bed. Hydrogen sulfide produced during the cracking and partial combustion of the oil is removed by the lime to yield a clean fuel gas and sulfided lime. The hot, low-sulfur, low-Btu fuel gas is burned in a steam generator. The process can be operated as a once-through, throwaway limestone system or as a limestone regeneration/sulfur recovery system. The sulfided lime can be converted to calcium sulfate in an air-fluidized vessel, operating near 1500°F, for dry disposal in the once-through concept. The regeneration system converts the sulfur in the stone to SO₂ in an air-fluidized bed operating near 1900°F. The regenerated stone is circulated back to the gasifier and the SO₂-rich stream (~10 mole %) goes to a sulfur or sulfuric acid recovery system. The technical feasibility of the concept was demonstrated. Sulfur removal up to 95% was achieved. Specifications and design concepts are developed for retrofit on existing utility boilers and for new plants based on experimental data. Conceptual designs, performance, and costs for retrofit systems show that the concept offers an economic method for achieving SO₂, NO_x, and particulate emission regulations. Capital cost of a retrofit, once-through gasification system is estimated to be 50 to 70% less than a retrofit wet-scrubbing system. Combined capital and operating costs for the gasification process may be 30 to 50% less in intermediate-load plants than such alternatives as wet scrubbing or the use of low-sulfur oil products. Plant reliability may be increased with the gasification system due to reduction in SO₂, vanadium, and sodium before the boiler. A demonstration installation of an add-on oil gasification unit on an existing utility boiler is recommended. (5 figures, 8 tables) (auth)

1973

203B

CN-140, 583

OPTIMIZATION OF COAL GASIFICATION PROCESSES
FOR SYNTHETIC NATURAL GAS PRODUCTION. LA, C. T. H.
Morgantown, WV; West Virginia Univ. (1973). 181p. University
Microfilms Order No. 73-23,882.

Thesis (Ph. D.).

Eleven alternate coal gasification processes to produce 250 billion Btu per day of synthetic natural gas were calculated and the performances of the different processes were compared, based on their optimal thermal efficiencies. In order to optimize the thermal efficiency of each alternate, thermal dynamical models for the alternates were first constructed according to specifications provided by the Office of Coal Research for the synthetic natural gas production. By applying the "Complete Technique for Optimization" the optimal thermal efficiencies were computed. The prices of synthetic natural gas produced from the different alternate processes were also calculated, based on the results of sub-system equipment design optimizations and using the standardized O. C. R. - A. G. A. accounting procedure. Since the raw material (coal) cost constitutes a large portion of the final gas price, the process with the largest thermal efficiency was found also to have the lowest final gas price. The process that utilizes most of the volatile matter of coal and produces the most methane in the gasification stage, rather than in the final methanation stage, was found to have higher thermal efficiencies. To effectively produce methane in the gasification stage, a hydrogenolysis and hydrogenation of the raw coal in a hydrogen-rich atmosphere are desirable. This hydrogen is generated by gasifying the hydrogenated coal residue, then shifting and purifying the produced synthesis gas. (Dis. Abstr. Int. B)

1973

IN SITU GASIFICATION OF COAL BY GAS FRACTURING. Rhoades, V. W. (to Cities Service Oil Co.). US Patent 3,775,073. 27 Nov 1973. Filed date 27 Aug 1971. 6p.

Two or more wells are drilled into a coal seam. The wells are completed so as to isolate all other strata from the coal seam and a radially extended horizontal fracture is directed by introduction of a first combustion supporting gas under hydraulic pressure so as to connect the wells communitively. A horizontally and vertically directed fracture network is formed within the coal system by ignition of the first combustion supporting gas. A second combustion supporting gas is subsequently injected through at least one well to form a combustion front that may be propagated through the fracture network to produce combustible gases and coal tar liquids. (with)

CN-140, 522

(UCRL-51340) ECONOMIC ESTIMATES OF THE
LAWRENCE LIVERMORE LABORATORY CONCEPT OF IN-SITU
COAL GASIFICATION. Stephens, D. R. (California Univ., Livermore. Lawrence Livermore Lab.). 7 Feb 1973. Contract W-7405-Eng-48. 12p. Dep. NTIS.

For a description of the Lawrence Livermore Lab. in situ coal gasification concept see UCRL-51217(Rev.1) (NSA 27: 235). Two cases, to cover the extremes of expected gas qualities, are calculated here. In the first, only CO₂ removal was considered to be needed to produce pipeline-quality gas; and, in the second, surface facilities for sulfur removal and methanation, in addition to CO₂ scrubbing, were required. Capital investment and operating costs for the two cases are presented. In addition, a sample cash-flow calculation is shown, a graph summarizes gas selling price vs internal rate of return, with royalties and depletion allowances for gas and for coal. All cases considered are based on an annual production of 100 billion scf of pipeline gas, an underground pressure of 450 psi, and enough oxygen to burn 20% of the coal. All costs are in 1971-1972 dollars. (LMT)

GAS FROM COAL. Papamarcos, J. Power Eng.: 77: No. 2, 32-39(Feb 1973).

Coal gasification work has progressed to the point where important developments may be expected in rapid succession. Only one of the processes described here is considered commercial at this time, but the incentives are great to prove out others which may be more economical. (auth)

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GASIFICATION OF COAL. Perry, H. Sci. Amer.: 230: No. 3, 19-25(Mar 1973).

Coal represents more than 90% of the proved reserves of all developed fuels. At the 1972 rate of consumption, the proved coal reserves will not be exhausted for 600 years. If coal were the sole source of energy and the total demand rose 3.5% per year, the proved reserves would last for 47 years and total coal reserves for nearly 75 years. Gasification is being examined as a major source of clean energy use. The Lurgi process and the Koppers-Totzek process are described. Two new processes that have reached the demonstration stage are the HYGAS process and the CO₂ Acceptor process. Other processes approaching the pilot-plant stage include the Bt-Gas process and the Synthene process. Capital requirement, operating costs, and average gas cost are discussed. The new technology of gasifying coal underground is described. (MCW)

1973

HYDROCRACKING OF MONTANA COALS THROUGH THE USE OF MASSIVE QUANTITIES OF MOLTEN SALT CATALYSTS. Scarran, W. P. Bozeman, MT; Montana State Univ. (1973). 109p. University Microfilms Order No. 73-27,492. Thesis (Ph. D.).

The use of massive quantities of molten salt catalysts was investigated for the hydrocracking of two Montana coals: Colstrip sub-bituminous and Savage lignite. The catalytic component of the molten salt was $ZnCl_2$; various alkali metal halides were used as the noncatalytic component to reduce the viscosity of the molten salt and promote phase separation between the hydrocarbons and salt mixture. Experiments were run in a 500-ml rocking-bomb reactor and conversions were based on reaction products soluble in benzene. Tests used to simultaneously investigate the importance on conversion of seven process parameters showed no effect of the following between the levels indicated: pressure (2000 to 3000 psig); salt: coal weight ratio (2:1 to 4:1); and $KCl: ZnCl_2$ mole ratio (1:2 to 1:1). Significant effects were attributed to these parameters between the levels indicated: temperature (350 to 450°C); time (15 to 60 min.); mixing (static-rocking); and coal size (-40 + 100 to -100 mesh). Good conversions (>85 wt %) were attained using both coals and the parameters affected conversion essentially the same for both coals. Additional tests showed that the pressure should be greater than 2000 psig and the coal particle size smaller than 140 mesh. It was also observed that $KCl: ZnCl_2$ mole ratios as low as 0.2:1 might be feasible and that the noncatalytic component of the salt mixture to KCl relative to conversion when used as the noncatalytic component of the salt mixture. The $ZnCl_2$ in the molten salt mixture eventually became poisoned with resultant lower conversions, poorer phase separations, and more tar-like products. The use of exposable quantities of $ZnCl_2$ in noncatalytic molten salt mixtures was not promising. Metal chlorides of metals more and less active than zinc did not act as catalyst accelerators (compounds that would react with the catalyst poisons in preference to $ZnCl_2$). Comparisons of gas removal at reactor operating temperatures and at ambient temperatures showed the former retarded the onset of poor phase separation and more tar-like products. It also resulted in a higher H: C mole ratio in the products and less retention of nitrogen (the suspected catalyst poison) in the salt mixture. (Disc. Abstr. Int.; B)

PRODUCTION OF FUEL GAS. Slater, W. L.; Schlinder, W. G.; Crouch, W. B. (to Texaco Inc.). US Patent 3,754,364. 8 Jan 1974. Filed date 4 Nov 1971. 6p.

Fuel gas suitable for use in conjunction with a gas turbine is prepared by subjecting a hydrocarbon oil to partial combustion using air as the oxidizing medium and injecting additional hydrocarbon oil into the hot partial combustion products. (Official Gazette)

1973

COAL GASIFICATION: EQUILIBRIUM PROBLEMS IN HIGH-TEMPERATURE COMBUSTION. Spencer, F. E. Jr.; Orning, A. A.; Blenstock, D. (Bureau of Mines, Pittsburgh). Chem. Eng. Progr.; 69: No. 3, 60-62(Mar 1973).

A new multiphase chemical equilibrium program designed to cope with problems in high temperature coal combustion operates at least 300% faster than a similar program developed previously. The mathematically sophisticated techniques responsible for the new speed are educated guessing of solutions of chained problems; symmetry of the Jacobian matrices to be inverted; skipping of inversion when convergence is near; and accommodation to zero items in the stoichiometric specification of a problem which leads rather than to matrix singularity, to a marked speedup in the operation without data bank reconstruction. Applications considered included slag vaporization; flame temperature; electrical and transport properties; and the design of a novel three-stage gasifier-combustor system now under construction as a pilot plant at Pittsburgh Energy Research Center. A study of the thermodynamics of aged regeneration was made. (MCW)

(UCID-16265) PRELIMINARY COAL GASIFICATION EXPERIMENTS. Pasternak, A.; Taylor, R. W.; Bowen, D. (California Univ., Livermore. Lawrence Livermore Lab). 11 May 1973. Contract W-7405-eng-48. 24p. Dep. NTIS \$3.25.

The reaction rates of a Wyoming subbituminous coal heated in steam and steam-hydrogen mixtures were investigated at temperatures up to 725°C. At about 500°C pyrolysis produces methane, carbon dioxide, and char. Pyrolysis may be a significant source of methane in an in situ process. The minimum temperature for rapid reaction of coal or char with steam or steam-hydrogen mixtures is about 625°C. The products are mostly hydrogen and carbon dioxide. Gasification rates decrease with time at a fixed temperature. Methane production increases when hydrogen is added to the steam. The activation energy for gasification in a large excess of steam was found to be 25 kcal/mole. (auth)

N74-19047 #

(SLA-73-946) FRACTURE OF COAL AND OIL SHALE FOR IN-SITU PROCESSING OR REMOTE REMOVAL: A PROPOSAL SUPPORT DOCUMENT. Tyler, L. D.; Weart, W. D. (Sandia Labs., Albuquerque, N. Mex. (USA)). Oct 1973. Contract AT(29-1)-789. 17p. Dep. NTIS \$3.00.

A detailed description is given of work proposed for the fracturing of coal and oil shale formations in-situ. The proposal sets forth the concept of using the synergistic effects of a combination of hydraulic and explosive techniques to fracture these formations in a controlled manner. (auth)

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Gasification of Fossil Fuels under Oxidative, Reductive, and Pyrolytic Conditions.

A. L. Yergey, F. W. Lampe, M. L. Vestal, E. J. Gilbert, and G. J. Fergusson.
Scientific Research Instruments Corp., Baltimore, Md. Dec 73, 184p SRIC-72, EPA-650/2-73-042
PB-228 668/OWE PC\$12.25/MF\$1.45

The report contains kinetic reaction data produced in a non-isothermal kinetics laboratory while gasifying selected types of coal under oxidative, reductive, and pyrolytic conditions. Types of coal cover the range, including lignite and anthracite. Evolution of thermal decomposition products under study conditions were investigated at different fuel heating rates and gasification pressures. Gaseous product evolution rates, as the function of temperature, were graphed for different coals exposed to indicated gasification regimes. The evolution of such gaseous species as H₂O, CO, CO₂, O₂, SO₂, NO, H₂, CH₄, H₂S, and C₂H₂ was followed up in conjunction with 13 different coal gasification reactions as identified previously and in the course of this work. The kinetic reaction parameters, such as activation energy and frequency factors for these reactions, were calculated and presented earlier and in this report.

1973

Evaluation of Coal-gasification Technology, Part 1—

Pipeline-quality Gas

Issued April, 1973

R&D Report No. 74—Interim Report No. 1

Contractor: National Academy of Engineering

Refer to: Titled report and GPO Catalog No. 163.10:74/

Int. 1 and Stock No. 2414-00057

Price: \$0.85

Optimization of Coal Gasification Processes

Issued April, 1973

R&D Report No. 66—Interim Report No. 2

Contractor: West Virginia University

Refer to: Titled report and GPO Catalog No. 163.10:66/

Int. 2 and Stock No. 2414-00054

Price: \$0.75

Development of CSF Coal Liquefaction Process

Issued August, 1973

R&D Report No. 39—Final Report, Volume V

Contractor: Consolidation Coal Co.

Refer to: Titled report and GPO Catalog No.

163.10:39/Vol V and Stock No. 2414-00060

Price: \$0.75

1973

Costs of gasification high

Anon., Energy Digest, 2, (3), 32-36, (May 1973). Reference is made to a report produced by the Edison Electrical Institute that forecasts the availability and prices of coal, oil, natural gas and uranium, and examines world resources in terms of their economic, environmental, domestic and international "inter-fuel relationships". The gasification of high sulphur coals is also mentioned. The article gives capital, annual owning and operating costs for a first-generation Large gasification process in a 1 000 Mw nominal COGAS system.

Status of coal gasification

Cochran, N. P., A. I. Ch. E. Paper 7c presented at the 74th National Meeting of the American Institute of Chemical Engineers, New Orleans, March 11-15, 1973. 10 pp. The U. S. Dept. of the Interior is currently investigating 4 coal gasification processes which are sufficiently different to require testing at a pilot-plant scale. The basic coal gasification process is briefly discussed before the specific processes under investigation: the HYGAS, CO₂ Acceptor, BI-GAS, and Agglomerated Ash.

Coal gasification, how soon?

Dolton, G. H., A. I. Ch. E. Paper 7a presented at the 74th National Meeting of the American Institute of Chemical Engineers, New Orleans, Mar. 11-15, 1973. 22 pp. G. H. Bolton of Columbia Gas System Service Corp. examines the cost of natural gas relative to other fuels, establishes the need for coal gasification, and reports coal gasification's status among gas supply alternatives from the viewpoints of economics, commercial technology, and the resultant indicated timing of plant construction.

Papamarcos, John, "Gas from Coal", Power Engineering, February, 1973.

"Evaluation of Coal-Gasification Technology - Part 2, Low and Intermediate Btu Gases", R & D Report No. 74, Contract No. 14-32-0001-1216, Office of Coal Research, Wash. D. C., to be published in late 1973.

Siegel, H. M. and Kalina, T., "Technology and Cost of Coal Gasification", Mechanical Engineering, May, 1973.

Substitute natural gas from coal

Schora, F. C., Pipeline Gas J., 200, 28-31, (May 1973). 4 pp. A review of the major conversion processes under consideration in U. S. today.

Substitute natural gas process passes pilot-plant test

Anon., Oil Gas J., 71, (15), 32-33, (9 Apr. 1973). A description is given of a new synthetic SNG process called H-Gas, developed by Hydrocarbon Research Inc, that is designed to feed low-grade hydrocarbons. The process now ready for demonstration-plant evaluation, converts high-sulphur resid, coal tar, or shale oil. Broken down costs of the process are given. The pipeline-gas price is set at 98 ¢/mill. BTU from a 250 mill. cfd plant with \$2.50/bbl. feed.

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THE PETROLEUM/PETROCHEMICAL INDUSTRY AND THE ECOLOGICAL CHALLENGE. George H. Cummings, ed. (Contains abstracts of papers presented at the Seventy-fourth National Meeting of the AIChE in New Orleans this year).

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Evaluating the Bi-Gas synthetic natural gas process

Hegarty, W. P., and Moody, B. E., Chem Engng Prog, 69, (3), 37-42, (Mar., 1973). This is a revised version of an OCR report, which describes and discusses the engineering evaluation of the Bi-Gas coal gasification process carried out by Air Products & Chemicals Inc. on behalf of the Office of Coal Research. Details of the gasifier operating conditions were provided by Bituminous Coal Research, as well as heat and materials balances. Utilizing the data provided, APCI has developed a preliminary design for a 250 million ft³/day plant. The economics of the process have been investigated and it is pointed out that although there are a number of potential problems, the process is theoretically sound and the prospects for development are good.

Coal gasification: state of the art

Anon., Heating Piping Air Conditioning, (1), 149-155, (Jan. 1973). The article explains the basic principles of coal gasification. It surveys the natural gas supply position, the need for the development of new gas supplies, and the Lurgi Hygas electrothermal, Hygas oxygen, CO₂ Acceptor, BI-GAS, and Synthane processes for coal gasification.

Gas from coal

Anon., Power Engng., 77, (2), 32-41, (Feb. 1973). Only coal gasification seems to offer the U.S.A. a long range solution to fossil fuel needs that will be accepted on all counts, particularly reliability, economics (including balance of payments considerations) and national security. Reference is made to the Lurgi, HYGAS, CO₂ Acceptor, BI-GAS, Synthane, ATGAS, COGAS, a new Kellogg, and Union Carbide Corp processes, low Bu gas, underground gasification, evaluation of processes, Lurgi plants planned, and other sources of clean fuel.

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DECLINING DOMESTIC RESERVES - EFFECT ON PETROLEUM
AND PETROCHEMICAL INDUSTRY. C.H. Cummings, ed.
(Contains papers presented at the 71st National
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TECHNOLOGY AND COST OF COAL GASIFICATION.
H.M. SIEGEL AND T. KALINA.

Mechanical Engineering, v.95, no.5, May 1973,
p23-28.

Gas from coal

Papamarcos, J., Pwr Engng., 71, 32-9, (Feb. 1973). Coal gasification appears at present the only solution to future fossil fuel needs that is acceptable with regard to reliability, economics and national security. The Lurgi, Koppers, Hygas, CO₂ Acceptor, Bl-Gas, Synthase - and other processes are described and underground gasification considered briefly. One or other of these processes may become commercially available by 1980.

COAL GASIFICATION: THE NEW ENERGY SOURCE.
Williams, J. E.; Dressel, J. H. (Stearns-Roger Inc., Denver).
CIM (Can. Mining Met.) Bull.; 66: No. 730, 72-77(Feb 1973).

This review of coal gasification describes processes available today and in the future. Winkler, Koppers-Totzek, and Lurgi processes are briefly described. The Lurgi Process has been applied extensively for practically all of the first-generation projects. Some new processes include Bituminous Coal Research's BIGAS Process, Consolidation Coal's "CO₂ Acceptor" Process, and the Institute of Gas Technology's "HYGAS" Process. All these processes use fine coal and employ fluid beds in which the coal particles are either suspended or carried along by the gases in the gasifier. They do not have moving parts inside the gasifier. The processes may allow scale-up to much larger sizes than the Lurgi gasifier and possibly reduce the capital cost for gasifiers. Initial engineering progress for commercial plants is being made on low-BTU gas projects for the power industry and high-BTU gas projects to produce synthetic natural gas. An illustration is described to show the size of the mine and coal preparation plant necessary to support a 250-MMscf/D gasification plant and to show some of the difficulties encountered in the materials handling for a commercial gasification plant. (MCW)

(BNL-18268) **CENTRIFUGAL COAL FLASH HYDRO-GENERATION IN A ROTATING FLUIDIZED BED REACTOR FOR A FULL-SIZED COAL LIQUEFACTION PLANT.** Sheehan, T. V.; Steinberg, M.; Lee, Q. (Brookhaven National Lab., Upton, N. Y. (USA)). Aug 1973. 34p. Dep. NTIS \$3.75.

A short contact time (<5 sec), high-temperature (>1000°F), high-pressure (>68 atm) reaction of hydrogen with coal favors high conversions to liquid hydrocarbons. The rotating fluidized bed is uniquely suited for obtaining these process conditions. The centrifugal force in the rotating bed maintains the coal particles in position against the high velocity stream of fluidizing hydrogen. The gravitational degree of freedom in a rotating fluidized bed yields extremely high heat transfer and reaction rates. One rotating fluidized bed unit 5 ft dia. x 2.5 high should be able to process 9,000 T/D of coal at 60% conversion efficiency for the production of the equivalent of 38,000 bbl/day of liquid hydrocarbon product. A design analysis of the centrifugal hydrocarbon unit and the entire plant as well as a preliminary cost estimate is presented. (auth)

COAL GASIFICATION: THE NEW ENERGY SOURCE.
Williams, J. E.; Dressel, J. H. (Stearns-Roger, Inc., Denver). pp 47-52 of Mining Year Book, 1973. Denver, Colorado Mining Association (1973).

From National western mining conference and exhibition, Denver, Colorado, USA (8 Feb 1973). See Conf-730219-
Coal gasification is a means for solving the energy-ecological crisis in the US. Information is presented on: what coal gasification is; gasification processes presently available; new processes under development; types of gasification projects being studied on a commercial scale; the size of the mine and coal preparation plant necessary to support a 250-MMscf/D gasification plant, and some of the difficulties encountered in materials handling for a commercial gasification plant. (LCL)

CRG-HYDROGASIFICATION PROCESS FOR SNG PRODUCTION. Weisa, A. J. (Lummus Co., Bloomfield, N.J.). Chem. Eng. Progr.; 69: No. 5, 84-90(May 1973).

The first plant to produce commercial SNG, interchangeable with natural gas, went on-stream in Portsmouth, England using the CRG-Hydrogasification process with one stage of methanation. The plant has operated with light and heavy naphtha as the feedstock, and the CRG catalyst in the hydrogasifier was successfully regenerated. The process is an improvement over the CRG process with two stages of methanation because of the higher thermal efficiency achieved by lower steam:feedstock ratios. Regeneration of the CRG catalyst offers the potential for further cost reduction in the production of SNG. The production of SNG from petroleum liquids will become a reality in the USA in 1973. The cost of the gas produced by these plants will be higher than the natural gas sold during the past three decades. (MCW)

COAL GASIFICATION: MOLTEN SALT PROCESSES FOR SULFUR EMISSION CONTROL. Glueck, A. R. (Chemical Technology Corp., Lawrenceville, NJ). Chem. Eng. Progr.; 69: No. 3, 56-57(Mar 1973).

Two molten salt desulfurization processes are illustrated. Pre-combustion desulfurization of coal takes place in a single vessel. Pulverized coal, slurried with molten salt, is allowed to react with a melt that contains an agent with an affinity for the sulfurous compounds. The coal collects at the top, being less dense than the melt, and is drawn off continuously. The melt and coal are separated, and the accumulated sulfur, plus any soluble ash components, are removed from the melt in a side operation, after which the salts are returned to the reactor. The indirect oxidation of coal with attendant production of steam directly relies on the fact that coal attains a reasonable rate of oxidation at 600- to 800°C (1100-°F), while current power plants require steam at about 1000°F. Instead of merely operating to oxidize the sulfur, flameless oxidation of the coal will take place utilizing chemically bound oxygen from the salts. The offgas will thus be more concentrated, and the sulfur, now comprising almost 1% of it, will be more advantageously removed. The spent salt, now in a reduced form, goes first to a unit to remove ash, by centrifugation or filtration, and then to the salt regenerator for reoxidation to its original form. The oxygen-depleted air from the regenerator should not require further treatment before release to the atmosphere, save heat exchange to recover its thermal energy. The steam tubes lead directly into the combustor, providing 2,600 lb steam in a single pass. Ash components are drawn off at the bottom of the reactor in both processes. (MCW)

POWER GAS AND COMBINED CYCLES: CLEAN POWER FROM FOSSIL FUELS. W.D. Metz.

Science, v.179, no.4078, Jan.5,1973, p.54-56.

SULFUR DEVELOPMENTS: LOW B.T.U. GAS FOR POWER PLANTS. Conn, A. L. (Amoco Oil Co., Whiting, IN). Chem. Eng. Progr.; 69: No. 12, 56-61 (Dec 1973).

Direct combustion of high-sulfur coal presents problems. An alternative is the production of low Btu gas from coal. Two advantages of this process are: that the gas is produced under reducing conditions, with the result that sulfur is converted to H_2S , which can readily be removed by well-proven absorption processes; and secondly, the gas can be generated under pressure, permitting some operating economies in an existing power plant, and more advanced power plant design for a new plant. Some disadvantages exist due to the fact that the operation resembles chemical plant operation with controls of flow and composition, etc. **The Lurgi process is the only immediate commercial application, but the Texaco gasifier, Bameg-Winkler gasifier, Wellman-Galusha gasifier, B&W-DuPont gasifier, Westinghouse gasification process, Union Carbide gasification process, Bi-Gas process, and the Koppers-Totzek gasifier are discussed.** (35 references) (MCW)

TITLE: City College Studies of the Coalplex

AUTHOR: Squires, A.M.

CORPORATE AUTHOR: City College of The City University of New York, Dept. of Chemical Engineering

ADDRESS: New York, NY 10031

PUBLICATION DESCRIPTION: Report No. PB 229-101/AS, 15 p.

PUBLICATION DATE: 1973

SPONSOR: National Science Foundation, RANN Program

ABSTRACT: ---A team at the Department of Chemical Engineering at The City College of New York has begun "studies toward improved techniques for gasifying coal". Our primary objective is to study chemistries and unit operations that will be useful in a COALPLEX yielding substitute natural gas, high-octane gasoline, and clean electricity. We are also engaged in flowsheet studies to identify commercial opportunities and guide our experimental work. In a Coalplex, a first coal-treating step would "cream off" methane (SMC) and benzene-toluene-xylene (high-octane gasoline). Coke residue would be gasified with air to furnish a clean "power gas" -- i.e., a low-Btu fuel gas -- for generating equipment that combines gas- and steam-turbine cycles. (Auth)

AVAILABILITY: NTIS, PB-229-101/AS (\$8.00 paper copy/\$1.95 microfiche)

COLD FLOW MIXING STUDY OF A VORTEX COAL GASIFIER. Strickland, L. D. Morgantown, WV; West Virginia Univ. (1973). 213p. University Microfilms Order No. 74-227. Thesis (Ph. D.).

A cold flow model of a vortex coal gasifier was fabricated and evaluated experimentally to determine the geometric and fluid dynamic variables controlling the mixing between a vortex combustion stream and a separate, through flowing core gasification stream. The aluminum and transparent acrylic model incorporated a transparent outer body for flow visualization, an adjustable conical vortex exhaust valve, provisions for changing the inlet and outlet core tube diameters, and provisions for changing the core gap length. A smoke flow visualization test program and a quantitative gas mixing study employing a carbon dioxide vortex and an air core were conducted. Visual and quantitative data are presented to show the effects of important variables for counter-flowing and coflowing streams. Core mass retention and core exhaust purity are treated as the important data results. These results were found to depend primarily on the vortex inlet Reynolds number, a parameter related to the ratio of the vortex inlet Reynolds number to the core inlet Reynolds number, the core gap, and the core inlet tube diameter. A summary of the visual results illustrating the important effects is presented along with polynomial curve fits of the core mass retention data. Complete tabulations of the measured and calculated gas mixing data are also included. (Diss. Abstr. Int., B)

TITLE: University Research in Coal Utilization

AUTHOR: Squires, A.M.

CORPORATE AUTHOR: City College of The City University of New York, Dept. of Chemical Engineering

ADDRESS: New York, NY 10031

PUBLICATION DESCRIPTION: Paper CCERI-103

presented at the Advanced Coal Technology Research Conference, Carnegie-Mellon University, Pittsburgh, PA, June 19-20, 1973.

18 p.

PUBLICATION DATE: 1973

SPONSOR: National Science Foundation, RANN Program

ABSTRACT: This paper will concentrate upon: (1) need for large-scale experimentation with fluidized beds, especially beds for high fluidizing-gas velocity; (2) need for long range planning to provide energy supplies that are resilient in face of decline in worldwide availability of natural gas and oil; and (3) the related need for a vigorous cadre of alert fuels technologists, with strong ties between men in industry and universities. (Auth)

Production of Clean Fuel Gas From Bituminous Coal.

G. Curran, J. Clancey, B. Pasek, and M. Pell.
Consolidated Coal Co., Library, Pa. Research Div. Dec 73,
241p EPA-650/2-73-049
PB-232 695/7WE PC\$6.00/MF\$1.45

A process for the production of low-Btu gas from bituminous coals via fluid bed gasification is described. Coal processing consists of pretreatment, gasification, and final burnup. Hot fuel gas is desulfurized with half-calcined dolomite and cleaned of particulates in high-pressure drop cyclones. The sulfur acceptor is regenerated with steam and CO₂. A liquid-phase Claus reactor is used to process the H₂S in the regenerator offgas into elemental sulfur. Experimental data are presented which demonstrated feasibility of the major process steps. An economic evaluation of gas clean-up operations shows that regenerative use of acceptor is preferable to once-through, and that removal of particulates via cyclones, if feasible, is cheaper than water scrubbing with subsequent reheat. The cost of the gas desulfurization process including sorbent regeneration and sulfur recovery is of the order of 20 cents/MM Btu of product gas. (Modified author abstract)

**CONTINUOUS STEAM GASIFICATION OF COAL CHAR
IN AN ELECTROFLUID REACTOR.** Beeson, J. L. Ames, IA;
Iowa State Univ. (1973). 411p. University Microfilms Order
No. 74-526.

Thesis (Ph. D.).

An experimental investigation was made in which an electrofluid reactor for the steam gasification of coal char which was operated at atmospheric pressure over a temperature range of from 1500 to 1900°F. Both a single-phase and a three-phase alternating-current power supply were used to operate the reactor. Since the gasification of coal char is not a proven application of the electrofluid reactor, one of the purposes of the investigation was to explore the operation of such a reactor over long time periods to simulate the operation required of commercial units. A second purpose of the investigation was to obtain design information for electrofluid reactors. Calculation studies were made with published data in addition to the experimental work done with the reactor. Off-gas composition as a function of steam conversion was studied using a model which assumed the water gas shift and methanation reactions to be at equilibrium. Agreement of experimental data with the model was approximate at 1700°F, and the agreement improved with increase in temperature. An overall plug flow model was used to calculate inverse space velocity as a function of steam conversion; the fluidization effects were accounted for by using kinetic constants determined for fluidized bed reactors. The calculated steam conversions were in approximate agreement with the model at 1700°F; further, it was found that the reactivity of the coal char changed during the gasification, exerting a perceptible effect on the observed steam conversion. (MCW)

COAL GASIFICATION: A TECHNICAL DESCRIPTION.

Farmington, NM; Western Gasification Company (1973). 32p.
Coal gasification to produce SNG is nearly twice as efficient as the burning of coal to produce electric energy. Pacific Coal Gasification Company and Transwestern Coal Gasification Company are developing a project in New Mexico to produce 250

TITLE: Production of Low-Btu Gas from Coal in Combination with Advanced Power Cycles
AUTHOR: Dobner, S.; Gluckman, M.J.; Squires, A.H.
CORPORATE AUTHOR: City College of The City University of New York, Dept. of Chemical Engineering
ADDRESS: New York, NY 10031
PUBLICATION DESCRIPTION: Report CCERI-105, paper no. 48b presented at 65th Annual Meeting of The American Institute of Chemical Engineers, New York City, November 26-30, 1972, 28 p.
PUBLICATION DATE: 1972
SPONSOR: National Science Foundation, RANN Program

ABSTRACT: This paper reports on three procedures for providing clean low Btu power gas from coal for use in combined cycle power generating equipment: Lurgi fixed bed gasifier followed by low temperature sulfur removal; ash agglomerating fluidized bed gasifier followed by low temperature sulfur removal; and ash agglomerating fluidized bed gasifier followed by high temperature sulfur removal. Results demonstrate efficiency increases due to high temperature desulfurization. (NSP)
AVAILABILITY: NTIS, PB-228-857 (\$4.50 paper copy/\$1.85 microfiche)

TITLE: The Coalplex: Gas, Gasoline, and Clean Electricity from Coal
AUTHOR: Squires, A.H.
CORPORATE AUTHOR: City College of The City University of New York, Dept. of Chemical Engineering
ADDRESS: New York, NY 10031
PUBLICATION DESCRIPTION: Report No. CCERI 106, paper no. 65e presented at 65th Annual Meeting of The American Institute of Chemical Engineers, New York City, November 26-30, 1972, 34 p.

PUBLICATION DATE: 1972
SPONSOR: National Science Foundation, RANN Program
ABSTRACT: This paper describes how the bound hydrogen in coal can be utilized to produce a hydrogen-rich fuel which would be "cleaned off" leaving a residue that could be burned to generate electricity. The kinetics of methane and benzene production by coal hydrogasification in coke agglomerating fluidized beds are discussed. (NSP)

COAL LIQUEFACTION SOLIDS REMOVAL. Plocco, R. J.; Wilson, E. L. (to Esso Research and Engineering Co.). US Patent 3,790,467. 5 Feb 1974. Filed Date 24 Apr 1972. 14p.
Solid residues are more effectively separated from a coal extract enriched solvent of a coal liquefaction product, in a solids-liquids separation zone in which solids size is a separation parameter, by adding to the coal liquefaction product a certain tract liquid derived from the coal liquefaction product and containing at least 20 volume percent of materials boiling below about 400° F or at least 20 volume percent of materials boiling above about 1000° F. (auth)

(PB-224530-6-GA) CLEAN FUELS FROM COAL.
Cochran, N. P. (Office of Science and Technology, Washington, D. C. (USA)). 10 Nov 1972. 15p. NTIS \$3.00.

A study of the production of clean synthetic fuels from coal resulted in recommendations for a total program of \$1.51 billion. The work recommended is divided into a research phase at \$33.4 million, a development phase at \$315.0 million, and a demonstration phase at \$1.15 billion. Work is outlined for alternate processes to produce clean low-Btu gas, clean liquid fuels, and clean solid fuels from coal. Supporting work on the development of special equipment and improved materials along with economic and engineering studies are proposed and funds provided in the budget estimates. (GRA)

(UCID-16094) THERMODYNAMIC EQUILIBRIA FOR WYOMING COAL. Stephens, D. R. (California Univ., Livermore (USA)). Lawrence Livermore Lab.). 4 Aug 1972. Contract W-7405-eng-48. 39p. Dep. NTIS \$5.00.

As part of the program to evaluate in situ gasification of coal, the thermodynamics of Wyoming coal was calculated for pressures from 1 to 70 atm, temperatures from 600 to 1600°K, and varying steam-oxygen-coal compositions. Coal was not stable relative to carbon under any of the conditions investigated. Conditions favoring methane production included higher pressures, lower temperatures, and lower oxygen-to-water ratios. Calculated methane production was sensitive to the stability of carbon allowed to exist in the solid phase. If equilibria were frozen in the underground system at 30 atm and temperatures of 500°C or less, it is calculated that sufficient methane would be formed that surface methanation facilities would not be required. Higher-temperature equilibria would require these surface facilities. (auth)

(UCID-16155) THERMAL WAVE PROPAGATION MODELS FOR IN SITU COAL GASIFICATION. Sherwood, A. E. (California Univ., Livermore (USA)). Lawrence Livermore Lab.). 27 Oct 1972. Contract W-7405-eng-48. 20p. Dep. NTIS \$4.00.

The dynamics of in situ coal gasification is discussed for simplified models, assuming the coal deposit can be treated as a fixed-bed chemical reactor. A thermal wave is shown to propagate at a characteristic velocity much smaller than the gas velocity and of the order of a few feet/hour. Peak temperature and width of the wave are calculated for first and second order reaction kinetic models, assuming a single overall coal reaction. The thermal wave is broadened by the estimated low heat transfer rate between gas and solid. Calculated coal heating rates are on the order of a few degrees centigrade/hour. (auth)

QD 501
N28
1972

NATO Science Committee Conference on Catalysis, Santa Margherita di Pula, 1972.
Proceedings. Edited by Fred Basolo and Robert L. Burwell, Jr. New York, Plenum Press, 1973. P. 165 --
Held in December 1972.

HYDROCARBON ACTIVATION

CHAIRMAN: G. W. Parshall
*E.I. du Pont de Nemours & Company, Central Research Department,
Experimental Station, Wilmington, Delaware 19898, USA*

RECORDER: M. L. H. Green
*Inorganic Chemistry Laboratory, University of Oxford,
South Parks Road, Oxford OX1 3QR, England*

In view of the dwindling supply and increasing cost of natural gas and petroleum, the prime sources of energy for our society and feedstocks for our chemical industries, it is vital that we use them with utmost efficiency. Major contributions to more efficient use can be made by improving the selectivity with which industry carries out transformations of saturated hydrocarbons. Even minor improvements in the effectiveness of catalytic cracking and reforming can mean immense quantitative savings in crude hydrocarbon consumption. Improvements which lead to higher-quality motor fuel should also reduce the total amount of fuel consumed with attendant reduction of air pollution.

In the following pages, the status of research with respect to hydrocarbon activation is summarized and areas for future research are considered in terms of their practical application and theoretical significance. Given the diverse areas of strength amongst heterogeneous, homogeneous, and metalloenzyme catalysis, the opportunities for progress through multidisciplinary research seem attractive.

Shearer, H.A. and A.L. Conn. ECONOMIC EVALUATION OF COED PROCESS
PLUS CHAR GASIFICATION. Washington, For sale by U.S. Govt.
Print. Off., 1972. 60 p.

Prepared for Dept. of the Interior, Office of Coal Research
by the American Oil Co., Research and Development Dept., Whiting
Research Laboratories under contract no. 14-32-0001-1210.

1972-

The union carbide-chemico coal gasification process: A strategy for commercialization
Coles, E. T., Paper presented at the 4th Synthetic Pipeline Gas Symposium, Chicago, Oct. 30-31, 1972. 13 pp. The Union Carbide-Chemico coal gasification process, a 2-stage fluidized-bed gasification process, offers such advantages as 1) the capacity to process caking coals without special pretreatment, 2) production of a medium-Btu (300+ Btu/CF) product gas containing no tar, phenols, oils or other condensibles - eliminating water treatment of raw gas scrubber effluent, 3) production of substantially less CO₂ and 4) the use of smaller and less costly high-pressure particulate-free SO₂ removal systems. Details.

The Lurgi process. The route to S. N. G. from coal

Rudolph, P. F. H., Paper presented at the 4th Synthetic Pipeline Gas Symposium, Chicago, Oct. 30-31, 1972. 50 pp. Available from author at Lurgi Mineraltechnik GmbH, Fuel Technology Division, D-6 Frankfurt (Main), Germany. A review of the Lurgi Pressure Gasification process and other processes developed by Lurgi specifically for the treatment and purification of gases from coal.

"Evaluation of Coal-Gasification Technology - Part 1, Pipeline Quality Gas", R & D Report No. 74, Contract No. 14-32-0001-1216, Office of Coal Research, Wash. D. C., December, 1972.

Pittsburg and Midway Coal Mining Co., "Development of a Process for Producing an Ashless, Low-Sulfur Fuel from Coal, V. 1", R & D Report No. 53, Contract No. 14-01-0001-496, Office of Coal Research, Wash. D. C., May, 1972.

Wen, C. Y., et al., "Comparison of Alternate Coal Gasification Processes for Pipeline Gas Production", Paper presented at the 65th Annual Meeting of the American Institute of Chemical Engineers, New York, N. Y., November, 1972.

Feldman, H. F., et al., "Supplemental Pipeline Gas from Coal by the Hydrane Process", Paper presented at the 71st National Meeting, American Institute of Chemical Engineers, Dallas, Texas, February, 1972.

Optimization of Coal Gasification Processes
Issued April, 1972
R&D Report No. 66—Interim Report No. 1
Contractor: West Virginia University
Refer to: Titled report and GPO Catalog No. 163.10:66/
Int. 1
Price: \$6.25

Char Oil Energy Development—Project COED
Issued May, 1972
R&D Report No. 56—Final Report
Contractor: FMC Corporation
Refer to: Titled report and GPO Catalog No. 163.10:56
Price: \$4.00

Char Oil Energy Development—Project COED
Issued December, 1972
R&D Report No. 73—Interim Report No. 1
Contractor: FMC Corporation
Refer to: Titled report and GPO Catalog No. 163.10:73/
Int. 1
Price: \$1.25

300-MM Lbs/Yr Acetylene Plant—Avco Arc-coal Process
Issued May, 1972
R&D Report No. 67—Final Report
Contractor: Blaw-Knox Chemical Plants, Inc.
Refer to: Titled report and GPO Catalog No. 163.10:67
Price: \$3.25

1972

1972

Special Purpose Coals—Adsorption Characteristics of Coal and Chars
 Issued June, 1972
 R&D Report No. 61—Interim Report No. 1
 Contractor: Pennsylvania State University
 Refer to: Titled report and GPO Catalog No. 163.10:61/
 Int. 1
 Price: \$0.70

Special Purpose Coals—Mineral Matter and Trace Elements in U.S. Coals
 Issued December, 1972
 R&D Report No. 61—Interim Report No. 2
 Contractor: Pennsylvania State University
 Refer to: Titled report and GPO Catalog No. 163.10:61/
 Int. 2
 Price: \$1.50

Engineering Evaluation and Review of Consol Synthetic Fuel Process
 Issued June, 1972
 R&D Report No. 70—Final Report
 Contractor: Foster Wheeler Corporation
 Refer to: Titled report and GPO Catalog No. 163.10:70
 Price: \$4.25

CE-140,549 (1972)
THE TOSCOAL PROCESS FOR LOW TEMPERATURE PYROLYSIS OF COAL. Franklin B. Carlson, Louis H. Yerdumian and Mark T. Atwood. ((Presented at the 65th Annual Meeting of the AIChE, N.Y., N.Y., Nov. 26-30, 1972)). 16p.

(American Inst. of Chemical Engineers)

Coal Fuels - Synthesis

L-3-8-74
 L-4037A-001

PROCESS FOR A COAL GASIFICATION. Ban, T. E. (to McDowell-Wellman Engineering Co.). US Patent 3,787,192. 22 Jan 1974. Filed date 2 Mar 1972. 6p.
 A process is described for producing water gas containing a large quantity of hydrogen and involving the formation of a moving quiescent gas-permeable bed composed of both particles of coal and particles of spent coal or ash. The bed is passed through a series of zones in which, in a succession of cycles, the bed is permeated with an oxygen-containing gas preheated to a predetermined temperature and then a moisture-laden gas also preheated to a predetermined temperature. These gases are collected separately after they traverse the moving quiescent bed. The water gas may be used as an industrial gas, and the product-flue gas resulting from the portions treated with oxygen-containing gas may be recycled through the bed at a point downstream. The process provides a continuous economic procedure for gasification of coal. (Official Gazette)

TITLE: SWG - Substitute Natural Gas: Producing SWG from Crude Oil and Naphtha
AUTHOR: Dattkiewicz, B.; Spitz, P.M.
COMPANY: Union Carbide Corp.
ADDRESS: New York, NY
PUBLICATION DESCRIPTION: Chemical Engineering Progress, 68(12), 84-90
PUBLICATION DATE: 1972, December
ABSTRACT: The basic technology exists today to produce substitute natural gas from crude oil, or from any distillate fraction of the crude. The complexity of the process increases with the boiling point of the distillate feedstock, approaching that of a gasoline refinery for the heaviest fractions. SWG production in the future will depend on the availability of various feeds and its role in the total energy picture. (JRC)

N72-30877# Committee on Interior and Insular Affairs (U. S. Senate)
ADVANCED POWER CYCLES
 Washington GPO 1972 279 p refs Hearing pursuant to S. Res. 45 before Comm. on Interior and Insular Affairs, 92d Congr., 2d Sess., 8 Feb. 1972
 Avail: Comm. on Interior and Insular Affairs
 The hearings are reported concerned with new technologies for the environmentally acceptable generation of electricity from coal. The processes for the gasification of coal, and the problem in the removal of sulfur compounds are discussed. Summaries of the EPA activities in compliance with the Clean Air Act are included.
 F.O.S.

PB-206 048-D
Bureau of Mines, Washington, D.C.
PROPOSED SYNTHANE COAL GASIFICATION
PILOT PLANT TO DEMONSTRATE FEASIBILITY
OF CONVERTING COAL TO SUBSTITUTE
NATURAL GAS.
Draft environmental impact statement.
24 Jan 72, 18p ELR-1684

PC53 00
Descriptors: (*Environmental surveys, *Coal
gasification), (*Pennsylvania, Environmental sur-
veys), Pilot plants, Air pollution, Water pollution,
Noise (Sound).
Identifiers: *Environmental impact statements,
*Allegheny County (Pennsylvania), Synthane
process.

The Bureau of Mines has developed on a small
pilot plant scale a coal gasification process that
converts coal to sulfur-free substitute natural gas
(SNG). It is known as the Synthane Process. The
proposed action would construct and operate a
large pilot plant located at a Bureau research facility
near Pittsburgh, Pennsylvania in Buceton, Al-
legheny County. The plant will operate only 3
years. Some air, water, and ground contaminants
would be released by the plant. Some noise would
also be generated by plant construction and opera-
tion activities. No aesthetic impact by the plant is
anticipated.

PB-214 162/0
Consolidated Coal Co., Library, Pa. Research Div.
LOW-SULFUR CHAR AS A CO-PRODUCT IN
COAL GASIFICATION
O. P. Curran, W. E. Clark, Melvyn Peil and
Everett Gorn. Oct 72, 70p EPA-R2-72-060
Contract EPA-EHSD-71-15

Descriptors: (*Charcoal, *Desulfurization),
(*Bituminous coal, Gasification), Manufactured
gas, Feasibility, Coal, Sulfur compounds, Accep-
tor materials, Calcium carbonates, Air pollution,
Economic analysis.
Identifiers: *Low sulfur fuels, Char.

A feasibility study is presented for the case where
low-sulfur char is produced as a co-product with
low-sulfur producer gas in a gasification-desul-
furization operation with bituminous coal. Calci-
um carbonate is used as a sulfur acceptor. Experi-
mental data are also presented to support the
design feasibility study. These data show that
preoxidized coals are extremely responsive to
desulfurization under the conditions used in the
feasibility study. It is possible by this method to
produce low-sulfur char containing 0.5% or less
sulfur content. The economic evaluation shows
that it is possible to produce low-sulfur char at a
lower Btu cost than would be the case for
complete gasification to low-sulfur producer gas.
The value of the char, however, as a boiler fuel is
less than that of the producer gas itself. It is, there-
fore, concluded that there is no clear incentive to
produce low-sulfur char as a co-product in a gasifi-
cation-desulfurization operation. (Author)

PRODUCING SNG FROM CRUDE OIL AND NAPHTHA.
Dutkiewicz, B.; Spitz, P. H. (Chem Systems Inc., New York).
Chem. Eng. Progr.: 68, No. 12, 45-50(Dec 1972).

An overall review is presented of the technology available today
for the gasification of the whole range of crude-oil-derived feed-
stocks, as well as the factors influencing the choice and combina-
tion of various processes. The four gasification processes re-
viewed include low temperature catalytic steam reforming of light
naphtha; steam reforming plus gas recycle hydrogenation of heavy
naphtha; partial oxidation plus gas recycle hydrogenation of middle
distillates; and partial oxidation plus fluidized-bed hydrogenation
of whole crudes. Typical economies for the four gasification
schemes were developed. (MCW)

EIS-AA-72-5175-F
Bureau of Mines, Washington, D.C.
SYNTHANE COAL GASIFICATION PILOT
PLANT TO DEMONSTRATE FEASIBILITY OF
CONVERTING COAL TO SUBSTITUTE
NATURAL GAS.
Final environmental impact statement.
22 Aug 72, 85p* ELR-5175, FES-72-28
Supersedes report dated 24 Jan 72, PB-206 048-D.

Descriptors: (*Environmental surveys, *Coal
gasification), (*Pennsylvania, Environmental sur-
veys), Pilot plants, Air pollution, Water
pollution, Noise (Sound).
Identifiers: *Environmental impact statements,
*Allegheny County (Pennsylvania), Synthane
process.

The Bureau of Mines has developed a coal
gasification process that converts coal to sulfur-
free substitute natural gas (SNG). It is known as
the Synthane Process. The report presents the
environmental impacts which will occur through
the construction and operation of a large pilot
plant located at a Bureau research facility near
Pittsburgh, Pennsylvania. The plant is to
accumulate sufficient information to evaluate the
overall feasibility of a commercial plant producing
SNG; and to identify associated environmental
problems and study control measures as
necessary. Estimated duration of the project is
five years, including plant construction operation.

NTZ-18760#
Bureau of Mines, Pittsburgh, Pa. Energy
Research Center.
CLEAN AUTOMOTIVE FUEL: LABORATORY-SCALE
OPERATION OF THE SYNTHANE PROCESS
A. J. Fomey, W. P. Haynes, J. J. Elliott, and R. F. Kenny Feb.
1972 8 p refs
(TPR-49) Avail: NTIS

A high-Btu gas was made in order to demonstrate the
feasibility of using the gas as a nonpolluting fuel for automobiles.
The pilot plants were revised to combine the processes of coal
gasification, gas purification, and catalytic methanation into one
overall system. Tests in test automobiles showed the Synthane
gas was less polluting than natural gas. Author

CM-140,347

1972

ECONOMIC EVALUATION AND PROCESS DESIGN OF A COAL-OIL-GAS (COG) REFINERY. Marshall E. Frank and Bruce K. Schmid. (Presented at the Symp. on Conceptual Plants for the Production of Synthetic Fuels from Coal, 65th Annual Meeting of the AIChE, N.Y., N.Y., Nov.26-30,1972). 17p.

American Inst. of Chemical Engineers

Symposium on Conceptual Plants Nov.26-30, 1972
for the Production of Synthetic Fuels from Coal

Coal - Gasification Fuels - Synthesis

L-3-8-74

L-4037A-001

NEW FUELS - OLD COAL.

C.W. Ertel and J.T. Metcalf.

Mech. Engineering, Mar.1972, p.24-27.

A review of the logistic and engineering problems that need to be overcome in establishing a synthetic fuel economy based on coal conversion.

The synthane process - research results and prototype plant design
Forney, A. J., and McGee, J. P., Paper presented at the 4th Synthetic Pipeline Gas Symposium, Chicago, (30-31 Oct. 1972). 26 pp. The U. S. Bureau of Mines is now concentrating its research on the gasification and methanation steps of its synthane process for the gasification of bituminous coal, sub-bituminous coal, and lignite to SNG. The gasifier operation was tested by Hydrocarbon Research, Inc., on a larger scale than possible at the Bureau of Mines' laboratories in Bruceton, Pa.; the process will be demonstrated in a 75 ton/day plant to be constructed by the Lummus Co. in Bruceton for 1974 operation. The process is described.

GA

The COED and COGAS programmes

Eddinger, R. T., Paper presented at the 4th Synthetic Pipeline Gas Symposium, Chicago, (30-31 Oct. 1972). 8 pp. Reported are some of the recent results from the operation of a COED process pilot plant at Princeton, N.J., and the development of the COGAS process to convert coal to pipeline-quality SNG and a high-quality synthetic crude oil. Approximately \$7 million will be spent on large-scale pilot work to demonstrate the economic and technical viability of the COGAS process in the next 2 yr. Tables give coal analyses, pyrolysis, product yields, product gas analyses, hydrotreating conditions, example oil hydrotreating results, example filtration runs on COED oil, and solids in COED oil. Flow charts illustrate the COED and COGAS processes.

LIQUID FUELS FROM COAL, 1972. Goldman, G. K. Chemical Process Review No. 97, Park Ridge, NJ; Noyes Data Corporation (1972). 233p. \$36.00.

The conversion of coal to highest quality gasoline is now a technical feasibility. The economic difficulty exists in raising the hydrogen content from 5 wt % to about 14% for a typical gasoline. The chemical nature of coal is discussed. The book contains a collection of 101 U. S. patents categorized under the three processes: extractive conversion processes; hydrogenation processes; and carbonization processes. The patent literature covers a substantial amount of information not available in the journal literature. (MCW)

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1972

Intersociety Energy Conversion Engineering Conference, 7th, San Diego, Calif., 1972.
Proceedings. Washington, D. C., American Chemical Society, 1972.
1533 p. illus. 28 cm.

Conversion of Coal to Clean Power, R. A. Graff, S. I. Dobner, A. M. Squires

277

p.1152

PB-208 944
Catalytic Inc., Charlotte, N.C.
APPLICABILITY STUDY. COAL
GASIFICATION PROCESS.
Final rept.,
L. K. Jain, and T. J. Hixson. Mar 72, 26p* APTD-
1103
Contract EPA-68-02-0241

Descriptors: (*Coal gasification, Feasibility),
(*Manufactured gas, Feasibility), Industrial
engineering, Desulfurization, Air pollution,
Design criteria, Furnaces, Maintenance, Safety,
Cost estimates, Capital costs.
Identifiers: *Air pollution abatement, *Low sulfur
fuels.

The study objective was to determine the applicability of a commercial coal gasification process to electric utility and industrial boiler facilities for new installations and for the 'retrofit' of existing installations. Specific objectives were evaluation of the process with respect to cost, space limitations and operational, maintenance and safety aspects. In addition, a number of technical difficulties and unresolved problems are outlined. The use of the coal gasification process may offer potential capital cost savings, compared to existing methods of sulfur removal in the combustion of coal, markets for caking-type high sulfur coals (10,000 BTU/Lb. or less) and a method of reducing particulate emissions by converting coal to a cleaner fuel. (Author)

ERG PROCESS FOR SNG. Nobles, E. J.; Van Sickle, M.; Crossland, S. (J. P. Pritchard and Co., Kansas City, MO). Chem. Eng. Progr.; 68: No. 12, 39-44(Dec 1972).

The Catalytic Rich Gas process of the British Gas Council is being applied at Pritchard to improve the substitute natural gas process for converting large amounts of liquid fuel to gas. The successful design must combine efficiency, reliability, and cleanliness or ecologically acceptable procedures. The economics of SNG production is discussed. Catalyst regeneration, methanation, feedstock variations, carbon deposition, and instrumentation are discussed for the second generation adaptation of the ERG process. (MCW)

PAT-APPL-257 945 (79)
Atomic Energy Commission, Washington, D.C.
IN SITU COAL BED GASIFICATION.
Patent Application.
Gary H. Higgins. Filed 30 May 72, 24p
Government-owned invention available for
licensing. Copy of application available NTIS.

Descriptors: (*Coal gasification, *In situ com-
bustion), (*Patent applications, Coal gasification),
Manufactured gas, Methane.
Identifiers: Pat-CI-48-61, *Underground gasifica-
tion.

The invention relates generally to coal gasification and, more particularly, to an improved process for use in the in-situ gasification of deeply buried thick coal beds to provide high quality synthetic fuel gas. A relatively thick deeply buried coal deposit is selected having a coal bearing interval with a thickness or composite thickness of at least about 50 feet and situated far below the water table. A mixture of oxygen and fuel gas is introduced through the reactant input conduits and is ignited so as to heat the upper layer of fragmented coal to reaction. When the desired operating pressure is attained the product output conduits are opened and reactant water in an appropriate form together with oxygen are introduced to contact the ignited upper coal layer. Withdrawal of product gas is then correlated with reactant input to maintain operating pressure. Heat carried by the flowing reaction gases heats up the bed downwardly from the hot layer zone to a lower temperature than exists in the hot zone and further reactions productive of methane occur therein.

PB-209 274
Little (Arthur D.), Inc., Cambridge, Mass.
A CURRENT APPRAISAL OF UNDERGROUND
COAL GASIFICATION.
17 Apr 72, 280p* ADL-C-7367-1 BuMinces-OFB-
11-72
Contract SO1111357

Descriptors: (*Coal gasification, *Coal mining),
Reviews, Evaluation, Feasibility, Research
projects, Boreholes, Carbonization, Coal
deposits, Combustion, Bibliographies, Joining,
Fracturing.
Identifiers: Coal vein linking.

The report describes a study to re-evaluate underground coal gasification technology. The technology was appraised to determine whether the current (1971) state of the technology offers a technically feasible method for gasifying coal underground that is applicable to reserves of bituminous and lower rank coals in the United States; whether a program of research and further development of the technology could ultimately make it a technically feasible alternative to current open-pit and underground coal mining operations; what the nature and cost of further research and development work in the technology should be. The study showed that underground coal gasification in the United States is technically feasible, but economic feasibility is yet to be determined. An annotated bibliography of 328 entries is also presented. (Author)

FLUIDIZED-BED HYDROGENATION PROCESS FOR
SNG. McMahon, J. F. (Foster Wheeler Corp., Livingston, NJ).
Chem. Eng. Progr.; 68: No. 12, 51-54(Dec 1972).

The fluidized-bed hydrogenation process provides a means of producing substitute natural gas from whole crude oil or crude oil fractions boiling above naphtha. The process can be operated as an independent grass-roots plant or integrated with other oil processing operations. The FBH process offers a great deal of flexibility in arriving at specific SNG production objectives by allowing for the cost/availability evaluation of a number of alternate feeds as well as a variety of operating methods. (auth)

CE-140,548

SCALE-UP FACTORS IN THE E-COAL[®] PROCESS.
Clarence A. Johnson, Michael C. Chervanek,
Earl S. Johnson, et al. (Presented at the
65th Annual Meeting of the AIChE, N.Y., N.Y.,
Nov. 26-30, 1972). N.Y. & Illns.

American Inst. of Chemical
Engineers

Coal

Liquefiers

Fuels - Synthesis

L-3-8-74

L-4037A-001

ELECTRIC POWER - VIA MARRIAGE OF CHEMICAL AND AERO-
SPACE INDUSTRIES.

F.L. Robson.

Chemtech, Apr. 1972, p. 239-249.

The approach that shows the most potential benefits involves essentially pollution free, low-heating value gaseous fuels for use in advanced-cycle power systems that operate at new levels of efficiency. Binary cycles, gas turbine systems, combined-cycle systems, and the COGAS systems are discussed.

GASIFICATION: A REDISCOVERED SOURCE OF CLEAN FUEL.
T.H. Maugh II.

Science, v. 178, no. 4056, Oct. 6, 1972, p. 44, 45.

CE-140,401

ANALYSIS OF A HYDROGEN COAL GASIFICATION PLANT
DESIGN. F.C. Schora and C.W. Matthews.
(Paper presented at A.I.Ch.E. 65th annual
meeting, New York, Nov. 27-30, 1972). 37p.

Institute of Gas Tech.
American Inst. of Chemical
Engineers

Coal - Gasification

Fuels - Synthesis

F-3-13-74

ENERGY REFINERIES ARE EYED.
J.H. Prescott.

Chem. Engineering, Sept. 18, 1972, p. 80-82.

Seven companies have requested U.S. government approval to import crude oil for conversion to either substitute natural gas or to low-sulfur fuel oil.

CLEAN POWER FORM DIRTY FUELS.

A.M. Squires.

Scientific American, Oct. 1972, p. 26-35.

Considerations of both efficiency and pollution control suggest that a major effort should be mounted to generate electric power with turbines operated on power gas produced from coal or oil.

New horizons for pressure gasification - the production of clean energy

Hebden, D., and Percival, G., Instn. Gas Engrs. J. 12, (8), 229-44, (Aug. 1972). Coal hydro-generation process, catalytic methane synthesis, fluid-bed hydrogenation (FBH), gas recycle hydro-generation (GRH), catalytic rich gas (CRG). The first two are concerned with the gasification of coal. The FBH was developed for crude and heavy oils, the GRH for medium oils and heavy naphtha, and the CRG for light naphtha and liquefied petroleum gases. Each process, therefore, has its place in a spectrum of feedstocks extending from coal to LPG. All these processes have a common objective - the production of methane, the simplest and most stable hydrocarbon and the principal constituent of natural gas. They are also all designed to operate at high pressure, a parameter that, thermodynamically, favours the formation of methane, facilitates the removal of sulphur and carbon dioxide, and minimizes capital charges.

(UCRL-51217(Rev.1)) NEW CONCEPT FOR IN SITU COAL GASIFICATION. Higgins, G. H. (California Univ., Livermore, Lawrence Livermore Lab.). 17 Sep 1972. Contract W-7400-eng-48. 28p. Dep. NTIS.

A method is described by which deeply bedded coals can be converted to methane through chemical reactions with oxygen and water. The coal would first be shattered with conventional explosives, then retorted with an oxygen-water mixture at between 700 and 1300°K. The reactants would be pumped into the top of the coal deposit at between 500 and 1000 psi and carbon dioxide and methane would be removed from the bottom. No sulfur gases or fly ash should be produced and the water requirements can be fulfilled from brackish water supplies. Coals available and suitable for this kind of gasification might yield as much as 10,000 trillion ft³ of pipeline gas. This constitutes about 300 times the present annual consumption, and if the process is successfully developed, it could materially alleviate future gas shortages.

Rough estimates of process costs based on a plant capacity of 0.1 trillion ft³ per year indicate that an investor could expect about 15% internal rate of return on a \$42 million capital outlay assuming 38¢ per MCF of gas as a field price. Both the capital requirement and selling price are much less than for surface gasification plants. Previous underground gasification has been accomplished with mined-gallery or drill-hole low-pressure burning. The method proposed here should minimize bypassing of the coal by the inlet gases and thereby maintain a high-quality product. This is accomplished by flowing the reactant gases very slowly downward through the shattered coal, keeping the hot zones above the colder ones. This creates a thermally stable advancing hot zone and avoids the mixing of reactants and products. The proposed process will lead to ultimate surface subsidence of many feet over the whole area of reacted coal. Experience from potash mines suggests that there would be no surface disruption.

While the concept appears most promising from a theoretical point of view, it is unproven. To test its feasibility it will be necessary to conduct a number of laboratory studies and calculations and to perform pilot-scale field tests in suitable deep coal deposits (auth)

HYDROGENATION OF COAL USING UNREDUCED CATALYST. Johnson, E. S.; Chervenak, M. C.; Wolk, R. H. (to Hydrocarbon Research, Inc.). US Patent 3,769,198. 30 Oct 1973. Filed date 24 May 1972. 6p.

The liquid-phase catalytic hydrogenation of coal to liquid and gas products is improved by the pretreatment of the catalyst with hydrogen, wherein the pretreatment temperatures are limited to about 300 to 400°F. The catalyst is substantially unreduced before startup oil is introduced into the reactor. (Official Gazette)

PG-219 985 PC33.00/MF\$0.95
Bureau of Mines, Washington, D.C.
STRONGLY CAKING COAL GASIFIED IN A
STIRRED-BED PROCESSOR.

Dept. of Investigations,
P. S. Lewis, A. J. Liberator, and J. P. McGee, Jun
72, 16p BuMiner-R1-7644

Descriptor: (*Manufactured gas, *Coal gasification), Bituminous coal, Beds (Process engineering).
Identifier: Stirred bed processors.

A stirred-bed gas producer has demonstrated gasification of strongly caking bituminous coal under pressure of six atmospheres. The gas of nominal 140 to 165 Btu per std cu ft calorific value could be burned in a boiler for generating steam. Coal flow, fuel level, and frequency and location of voids in the fuel bed were determined by nuclear tapes measuring density. Mechanical stirring throughout the bed was effective for keeping the fuel moving. (Author)

TITLE: An Economic Evaluation of Pipeline Gas from Coal

AUTHOR: Kattel, S.
CORPORATE AUTHOR: U.S. Dept. of Interior, Bureau of Mines

PUBLICATION DESCRIPTION: Report No. OP 103-73, 3

P., reprint from Gas, Chilton Co.
PUBLICATION DATE: 1972, August

ABSTRACT: The total cost of building and operating a plant to produce 250 MM scf/day of 977-Btu gas from Pittsburgh coal was calculated. Based on this calculation, the price of the gas will depend on the price of the coal as follows: coal \$2/ton, gas 67¢/Mscf; \$6/ton, 79¢/Mscf; \$8/ton, 90¢/Mscf. (MHC)

CE-140,546

1972

THE GARRETT RESEARCH AND DEVELOPMENT COMPANY
PROCESS FOR THE CONVERSION OF COAL INTO LIQUID
FUELS. Allan Sess. (Presented at the 65th Annual
Meeting of the AIChE, N.Y., N.Y., Nov.29,1972). 10p.

American Inst. of Chemical
Engineers

Garrett Research and Development Co. GRAD 72-050

Coal
Fuels - Synthesis
Liquefiers

L-4037A-001
L-5-7-74

TK

6540

.I 445

1972

Institute of Electrical and Electronics Engineers.
1972 IEEE international convention digest.
New York, 1972.

559 p. illus. 28 cm.

"Synopsis of Papers Presented at the 1972
IEEE International Convention March 20-23, 1972,
New York, N. Y."

"IEEE cat. no. 72 CHO 581-9 IEEE."

The Coalplex: Clean Energy from Coal,
A. M. Squires..... 144

SUBSTITUTE NATURAL GAS: ANOTHER ALTERNATIVE IN
THE ENERGY CRISIS. M. Wood.

Cryogenic Technology, Sept./Oct.1972, p.161-163.

Gas from the conversion of liquid hydrocarbons,
naphtha, crude oil or coal.

CE-140,550

1972

PROCESS DEVELOPMENTS: FIXED-BED CATALYSIS OF COAL
TO FUEL OIL. Paul M. Yavorsky, Sayeed Akhtar,
and Sam Friedman. (To be presented at 65th
Annual AIChE Meeting, N.Y., N.Y., Nov.26-30,1972).
17p.

American Inst. of Chemical
Engineers

Coal
Fuels - Synthesis
Fuels, Oil

L-5-8-74
L-4037A-001

MANUFACTURE OF LOW-SULFUR BOILER FUELS
FROM S-CONTAINING PETROLEUM BY THERMAL CRACKING
OF TAR AND HYDROCLEANING OF HEAVY DISTILLATES.
Teregulov, D. Kh.; Feigin, S. A.; Kostyukovskaya, M. B.; Kor-
shunova, L. N.; Kulikova, G. P. Khim. Tekhnol., No. 5, 38-39
(1972). (In Russian).

The scheme of the industrial-scale process is presented for
treating the residues from high-sulfur crudes to give an ash-free
liquid fuel with a sulfur content of 1.5 to 0.5%. Vacuum gas oil
from the direct distillation of petroleum and tar is used as the
raw material. An economic evaluation of the process indicates
that decreasing the S content from 1.8% to 0.5% increases the
capital expenditure 16% and the operating cost 38% for one of the
Russian petroleum streams studied. To achieve the 0.5% S, the tar must
be thermo-cracked and the residue boiling above 500°C com-
pletely recycled. More of the light fraction and less liquid fuel is
formed in this case. The uses of the products obtained at various
distillation stages (e.g., aviation fuel by hydrorefining of the
120 to 180°C fraction) are mentioned. (TTT)

TITLE: Coal Gasification a Partial Solution to
the Energy Crisis
AUTHOR: Sisselman, R.
CORPORATE AUTHOR: Mining Engineering
ADDRESS: 385 E. 87th St., New York, NY 10017
PUBLICATION DESCRIPTION: Mining Engineering,
28(10), 71-78

PUBLICATION DATE: 1972, October
ABSTRACT: The increasing demand for natural gas
in this country will lead to a definite
shortage in the next few years. Coal
gasification plants require a large capital
inventory, hence the price of gas must
increase substantially to make these
economically feasible. The processes under
development, or which have been developed,
are described in some detail. These include
WIGAS, CO2 acceptor, synthane, COGAS, Lurgi,
BI-GAS, Koppers-Totzek, and Westinghouse.
(JH-)

1971

Coal Gasification: A Review.

C. R. Aletta.
Cornell Univ., Ithaca, N. Y. Cornell Energy Project. Nov 71.
38p Paper-71-5, NSF-RA/N-71-015
PB-228 887/6WE PC\$5.00/MF\$1.45

Methods of underground and aboveground gasification of coal are reviewed. Four promising aboveground gasification techniques -- Hygas CO2 Acceptor Process, Bigas, and Synthane -- are described and compared. The objective of these four methods is to produce synthetic pipeline gas from coal. Recent trends, however, indicate that production of natural gas from gasification of naphtha feedstocks is likely to become commercialized earlier than production by gasification of coal. The environmental effects of fuel gasification of coal to supplement the deficiency of natural gas by the 1990's is discussed in the appendix. (Author)

COAL GASIFICATION. Hegarty, W. P.; Say, D. L.

(to Air Products and Chemicals, Inc.). US Patent 3,779,725.
18 Dec 1973. Filed date 6 Dec 1971. 8p.
A method is described for producing a synthetic pipeline gas by reacting a carbonaceous fuel in a gasifier. The gas is subjected to additional process steps including a final cryogenic separation of high methane content gas for use as the pipeline gas. (auth)

(NVO-544-1) COAL BREAKAGE WITH NUCLEAR EXPLOSIONS FOR IN SITU GASIFICATION. Lombard, David B. (Geo-Resource Associates, Arvada, Colo.). 30 Jun 1971. Contract AT(26-1)-544. 32p. Dep. NTIS.

A study is presented that examines the concept of breaking underground coal deposits with nuclear explosions in order to provide fracture permeability for subsequent in-place treatment. The treatment would presumably be aimed at converting the coal to methane gas. Four nuclear explosion cases were analyzed: a 100-kiloton chimney in the upper model interval; a 200-kiloton chimney in both levels; two 100-kiloton chimneys, together covering both intervals; and an array of seven 125-kiloton explosions designed to break both levels. Only coal that is in the chimney rubble is calculated in the first three cases. Fractured rock outside the chimneys is calculated for the array. Nuclear breakage of underground coal deposits is probably technically feasible. If an effective treatment method is developed, the costs of nuclear breakage in the overall economics of methane recovery would be minimal. The role of radioactivity and the possibility of subsidence during or after recovery of methane treatment should both be studied further. (auth)

1971

(OCR-20) GAS GENERATOR RESEARCH AND DEVELOPMENT. Phase II. Process and Equipment Development. Period of Performance, March 1965-September 1970. Final Report. (Bituminous Coal Research, Inc., Monroeville, Pa. (USA)). Mar 1971. Contract 14-01-0001-324. 571p. GPO \$10.25.

On Dec. 20, 1963 a program of gas generator research and development was initiated by Bituminous Coal Research, Inc. for the Office of Coal Research. Phase II involves experimental studies on the two-stage super-pressure coal gasification process initiated in March 1965. Batch tests in rocking autoclaves to continuous flow tests, first in an externally-heated 5 lb/hr flow reactor, and later in an internally-fired 100 lb/hr process and equipment development unit were performed. These experiments confirm the reactions of coal under conditions existing in Stage 2 of the two-stage process. The data were used in the design of a 100 lb/hr internally-fired Stage 2 reactor. Coals ranging in rank from lignite to high volatile A bituminous coal were used without difficulty. Based on results obtained from the 100 lb/hr process and equipment development unit, recommendations were made concerning the design of fully integrated 5 ton/hr pilot plant based on the two-stage super-pressure process. On June 18, 1969 the scope and nature of the Phase II studies were expanded to include additional testing of the Stage 2 PEDU, completion of the engineering design of the pilot plant, additional petrographic analysis, and initiation of bench-scale work on a fluidized-bed unit. In April 1970, work again was expanded to include gas purification and catalytic methanation and the application of fluidized-bed techniques in processes for gasification of char. Engineering evaluation and cost estimates of the two-stage super-pressure gasification process projected to full-scale commercial operation are summarized. The engineering evaluations and cost estimates of processes for a proposed multipurpose research pilot plant facility are reported together with the designing and planning for an oxygen-blown two-stage gasification system as the initial pilot plant in the facility. A summary is provided of the reports and publications emanating from the program. (MCW)

PB-200 800-F PC\$3.00/MF\$0.95

Office of Coal Research, Washington, D.C.
PROPOSED PILOT PLANT, HOMER CITY, PENNSYLVANIA.
Final environmental impact statement.
22 Feb 72. 71p ELR-1980. FES-72-4
Supersedes report dated 7 Jul 71, PB-200 800-D.

Descriptors: (*Environmental surveys, *Industrial plants), (*Pennsylvania, Environmental surveys), (*Coal gasification, Environmental surveys), Pilot plants, Industrial waste treatment.
Identifiers: *Environmental impact statements, *BI-GAS coal gasification plant, *Homer City (Pennsylvania), Indiana County (Pennsylvania).

The proposed pilot plant will test out a process employing oxygen and steam at elevated pressures in a two-stage gasifier, to convert coal to pipeline-quality gas, the exact equivalent of natural gas. No environmental problems are expected. In the case of malfunction, the plant will be shut down until it meets environmental requirements.

1971

73V29303 1971 ISS:00 TP759.L34 663.772 LC-72-601522

A CURRENT APPRAISAL OF UNDERGROUND COAL ♦♦ GASIFICATION; ♦♦

REPORT TO U.S. BUREAU OF MINES.

LITTLE (ARTHUR D.) INC.

(N.P.) 1 V. (VARIOUS PAGINGS) ILLUS. 28 CM.

"C-73671." COVER TITLE.

LC:COAL GASIFICATION; UNDERGROUND. COAL ♦♦ GASIFICATION; ♦♦

UNDERGROUND -- BIBLIOGRAPHY.

ADDED:UNITED STATES. BUREAU OF MINES.

MAIN-CORP TRACE-CORP+TITL+ CATLG BY-LC

/ / PUBL IN OTHER

1971

Engineering Evaluation of Project Gasoline, Consol

Synthetic Fuel Process

Issued January, 1971

R&D Report No. 59—Final Report

Contractor: Foster Wheeler Corporation

Refer to: Titled report and GPO Catalog No. I63.10:59

Price: \$2.75

1971

Economics of Generating Clean Fuel Gas from Coal

Using an Air-blown Two-stage Gasifier

Issued December, 1971

R&D Report No. 20—Supplement to Final Report

Contractor: Bituminous Coal Research, Inc.

Refer to: Titled report and GPO Catalog No. I63.10:20/

Sup 1

Price: \$0.45

Final Report of the Advisory Committee on Project

Gasoline

Issued January, 1971

R&D Report No. 62

Contractor: National Academy of Engineering

Refer to: Titled report and GPO Catalog No. I63.10:62

Price: \$0.30

Estimation of Coal and Gas Properties for Gasification

Design Calculations

Issued August, 1971

R&D Report No. 22—Interim Report No. 7

Contractor: Institute of Gas Technology

Refer to: Titled report and GPO Catalog No. I63.10:22/

Int. 7

Price: \$1.50

"Coal-Future Source of 'Synthetic' Fuels?", Chemical & Process Engr., p. 3, May, 1971.

1971

Char Oil Energy Development—Project COED—The
Desulfurization of COED Char, Part III
Issued January, 1971
R&D Report No. 56—Interim Report No. 2
Contractor: FMC Corporation
Refer to: Titled report and GPO Catalog No. I63.10:56/
Int. 2
Price: \$1.25

Electrothermal Hygas Process Escalated Costs

Issued June, 1971
R&D Report No. 22—Interim Report No. 6
Contractor: Institute of Gas Technology
Refer to: Titled report and GPO Catalog No. I63.10:22/
Int. 6
Price: \$0.40

DESULFURIZED COAL?

H.C. Messman.
Chemtech, Feb. 1971, p. 114-119.

The desulfurizing activity of caustic,
coupled with its high-temperature volatility,
portends an interesting area of R&D.

N-129,380 Bureau of Mines

LOW-SULFUR FUEL OIL FROM COAL. Sayeed Akhtar,
Sam Friedman, and Paul M. Yavorsky. (Tech. Progress
Rept.-35). July 1971.

CA-140,415 1970
A PROCESS TO MAKE HIGH-BTU GAS FROM COAL.
Albert J. Formey, Stanley J. Gasior, William P.
Haynes, et al. (Tech. Progr. Rept. 24). Apr. 1970. 6p.

Bureau of Mines

Coal - Gasification

LRC 74-18
L-3-18-74

(NP-19945) ENGINEERING EVALUATION OF
PROJECT GASOLINE; CONSOL SYNTHETIC FUEL PROCESS.
Research and Development Report No. 59. (Foster Wheeler
Corp., Livingston, N. J. (USA)). 28 Jul 1970. Contract 14-32-
0001-1203. 192p. GPO \$2.75.

Project Gasoline is a project to develop a process for con-
verting coal to gasoline at an economical price. Designs were
completed for the construction of a pilot plant with a capacity of
slightly less than one ton per hour of coal (equivalent to slightly
less than 60 barrels per day of a synthetic crude). The pilot plant
was intended to provide process data for design of a full-scale
commercial plant. The pilot plant was dedicated in May 1967, but
after 56 runs that terminated by mechanical and plant failure,
sufficient data is lacking for the design of a commercial facility.
After the closing of the plant, the engineering evaluation summary
was made. (MCW)

Consolidation Coal Co., "Summary
Report on Project Gasoline, V. 1,"
R & D Report 39, Contract No. 14-01-
0001-310, Office of Coal Research,
Wash. D. C., April, 1970.

Ralph M. Parsons Co., "1970 Final
Report - CONSOL Synthetic Fuel
Process", R & D Report No. 45,
Contract No. 14-01-0001-225, Office
of Coal Research, Wash. D. C., July,
1970.

**Char Oil Energy Development—Project COED—
Process Development Unit Results and Commercial
Analyses**

Issued May, 1970
R&D Report No. 56—Interim Report No. 1
Contractor: FMC Corporation
Refer to: Titled report and GPO Catalog No. I63.10:56/
Int. 1
Price: \$2.50

Summary Report on Project Gasoline—Volume I

Issued April, 1970
R&D Report No. 39—Interim Report No. 5
Contractor: Consolidation Coal Co.
Refer to: Titled report and GPO Catalog No. I63.10:39/
Vol. 1
Price: \$3.25

**Pipeline Gas from Lignite Gasification—Current
Commercial Economics**

Issued January, 1970
R&D Report No. 16—Interim Report No. 4
Contractor: Consolidation Coal Co.
Refer to: Titled report and GPO Catalog No. I63.10:16/
Int. 4
Price: \$0.50

1970 Final Report—Consol Synthetic Fuel Process

Issued July, 1970
R&D Report No. 45—Final Report
Contractor: The Ralph M. Parsons Company
Refer to: Titled report and GPO Catalog No. I63.10:45
Price: \$0.30

**Project Western Coal—Conversion of Coal Into
Liquids**

Issued August, 1970
R&D Report No. 18—Final Report
Contractor: University of Utah, Fuels Engineering
Dept.
Refer to: Titled report and GPO Catalog No. I63.10:18
Price: \$1.25

**Project Seacoal—Volume I with Appendixes A, B,
and C**

Issued January, 1970
R&D Report No. 29—Final Report
Contractor: Arco Chemical Co., Division of Atlantic
Richfield Co.
Refer to: Titled report and GPO Catalog No. I63.10:29/
Vol. 1
Price: \$1.25

Project Seacoal—Volume II with Appendix D

Issued January, 1970
R&D Report No. 29—Final Report
Contractor: Arco Chemical Co., Division of Atlantic
Richfield Co.
Refer to: Titled report and GPO Catalog No. I63.10:29/
Vol. 2
Price: \$4.00

N70-180559# Bureau of Mines, Pittsburgh, Pa. Coal Research
Center.

COAL INVESTIGATIONS USING LASER IRRADIATION

F. S. Karn, A. G. Sharkey, Jr., A. F. Logar, and R. A. Friedel Jan.
1970 36 p refs
(BM-R1-7328) Avail: Issuing Activity

Conditions necessary to obtain optimum yield of useful
products when coal is rapidly heated to extreme temperatures by
laser irradiation were determined. Product distribution and yield
were investigated as functions of several variables. Low rank coals
with high volatile matter gave highest total gas yields. Medium
rank coals gave the highest yields of H₂ and C₂H₂ and low rank
coals gave highest yields of CO and CO₂. Macerals gave gases of
approximately the same composition, but the total gas yield
increased in the order fusinite, micrinite, vitrinite, and exinite. Total
gas and C₂H₂ yields varied inversely with particle size. The
addition of nominally inert gases such as Ar, He, N₂ increased yields
of H₂, C₂H₂, and total gas. Metals such as nickel and platinum
had little influence on the rate of coal decomposition. Total gas
yield increased with total energy of irradiation, and the ratio of
C₂H₂-CH₄ increased with concentration of energy. A study was
also made of the irradiation temperature, and a material balance
was calculated. Author

CONVERSION OF COAL TO GASOLINE.

G.A. Mills.

Industrial & Engineering Chem., v.61, no.7, July
1969, p.6-17.

Paper presents new catalytic concepts for the
conversion of coal to gasoline and offers a possible
solution to a growing problem—the need for new
methods of fuel production.

R/HERRMANN; W. A. D. ♦♦ COAL ♦♦ BY ♦♦
OILS AND BASIC ORGANIC CHEMICALS FROM
HYDROGENATION; ♦♦ A LITERATURE REVIEW (BY) W. A. D. HERRMANN.
DEPT. OF ENERGY; MINES AND RESOURCES; MINES BRANCH; OTTAWA; V; 46 P.
ILLUS. 28 CM.

1.00 INFORMATION CIRCULAR 229 COVER TITLE. BIBLIOGRAPHY: P. 43-46.

LC: ♦♦ COAL ♦♦ ♦♦ LIQUEFACTION. ♦♦ PETROLEUM PRODUCTS.

ADDED: CANADA. MINES BRANCH (1950-) INFORMATION CIRCULAR 229

MAIN-AUTH TRACE-SERIS-CORP-TITL- CATALOG BY-LC

/ / PUBL IN CANADA

PC33.00/MF50.95
Scientific Research Instruments Corp., Baltimore,
Md.

KINETIC STUDIES ON THE PYROLYSIS,
DESULFURATION, AND GASIFICATION OF
COALS WITH EMPHASIS ON THE NON-
ISOTHERMAL KINETIC METHOD.

Final rept. on Phase 2.

Marvin L. Vestal, Alan G. Day, III, J. S.

Snyderman, Gordon J. Ferguson, and F. W.

Lampe. Dec 69. 110p. SRIC-70-14. APTD-1175

Contract PH-86-68-65

See also report dated Apr 69, PB-185 882.

Descriptors: (*Coal gasification, Reaction
kinetics), (*Desulfurization, Coal gasification),
(*Pyrolysis, Coal gasification), Bituminous coal,
Hydrogen sulfide, Dolomite (Rock), Limestone,
Iron sulfate, Pyrite, Calcium oxides, Steam,
Chemical equilibrium.

Identifiers: Air pollution abatement, Low sulfur
fuels, Sulfur containing fuels.

The research concerns sulfur control by means of
coal gasification. Previous work has shown that
desulfurization reactions on coal during pyrolysis
and gasification are inefficient under equilibrium
conditions. The experiments included
measurements on the desulfurization kinetics
(non-isothermal) for ten bituminous coals. An
extensive series of measurements were conducted
on the kinetics of H₂S reactions with coal char and
with the principal reactive constituents of char
including carbon, iron, and calcium oxide. The
kinetics of calcination for several dolomites and
limestones were investigated. Experiments were
also conducted on the pyrolysis of coal mixed with
calcium oxide and on the gasification of coal with
steam and oxygen both in the presence and
absence of calcium oxide.

CE-140,564 1969
PROJECT SEACOKE. VOLUME I. (Period covered:
Aug.1964-June 1969. APPENDIX C: THE CO-PYROLYSIS
OF COAL WITH PETROLEUM RESIDUA. M.R. Schmid and
B.D. McMunn. (Final rept. Jan.-Sept.1967), FMC
Corp., Dec.1,1967). 80p. & apps.

Office of Coal Research R&D
Washington, D.C. Rept.29

Atlantic Richfield Co.
FMC Corp. PCR-599

Contract 14-01-0001-473

Seacoke project
Coal
Fuels - Synthesis
Petroleum
189,652/145
L-5-23-74

CE-140,528 1969
SUMMARY REPORT ON PROJECT GASOLINE. VOLUME I.
W.E. Clark, D.R. Lindahl, G.D. Rutledge, et al.
(Period covered: Sept.1963-June, 1969). (1969).
122p. & illus.

Office of Coal Research, R&D
Washington, D.C. Rept.39

Consolidation Coal Co.
Contract (DI)-14-01-0001-310(1)

Coal - Gasification Gasoline project
Fuels - Synthesis

189,652/147
L-5-7-74

CH-126,810

1969
INFLUENCE OF RESIDENCE TIME, TEMPERATURE, AND
STREAM CONCENTRATION ON COAL-STREAM GASIFICATION
REACTIONS. J.L. Konebny and R.F. Stewart.
August 1969. 19p.

Bureau of Mines

RI 7284

Coal

Stream

Gases - Reactions

PB 105 556
L-11-3-73

1969

1969 Feasibility Report—Consol Synthetic Fuel
Process—Synthetic Crude Production
Issued July, 1969
R&D Report No. 45—Interim Report No. 2
Contractor: The Ralph M. Parsons Company
Refer to: Titled report and PB-184330
Price: \$6.00 NTIS

Szikla-Rozinek Coal Gasifier

Issued March, 1969
R&D Report No. 47 (1)—Interim Report No. 1
Contractor: The Franklin Institute Research Laborato-
ries
Price: \$3.00 OFFICE COAL RES.

Addendum to 1968 Feasibility Report—Consol
Synthetic Fuel Process
Issued April, 1969
R&D Report No. 45
Contractor: The Ralph M. Parsons Company
Refer to: Titled report and PB-183661
Price: \$6.00 NTIS

1969

1968 Feasibility Report—Consol Synthetic Fuel
Process
Issued February, 1969
R&D Report No. 45—Interim Report No. 1
Contractor: The Ralph M. Parsons Company
Refer to: Titled report and PB-183660
Price: \$6.00 NTIS

1968

Avco Arc-coal Process—Phase I—Feasibility Report
Issued August, 1968
R&D Report No. 34—Interim Report No. 1
Contractor: Avco Corporation, Applied Technology
Division
Price: \$1.50 OFFICE COAL RES.

Commercial Potential for the Kellogg Coal Gasifi-
cation Process
Issued October, 1968
R&D Report No. 38—Final Report
Contractor: The M. W. Kellogg Company
Refer to: Titled report and PB-180358
Price: \$6.00 NTIS

Chemical Byproducts from Coal
Issued November, 1968
R&D Report No. 43—Final Report
Contractor: Skeist Laboratories, Inc.
Refer to: Titled report and PB-180878
Price: \$6.00 NTIS

Conversion of Anthracite Coal to Acetylene
Issued June, 1968
R&D Report No. 33—Final Report
Contractor: Melpar, Inc.
Price: \$1.50 OFFICE OF COAL RES.

287

A/WU, WILLIAM R. K. ♦♦ BY W. R. K. WU AND H. H. STORCH.
HYDROGENATION OF COAL AND ♦♦ TAR, ♦♦
U.S. DEPT. OF THE INTERIOR, BUREAU OF MINES; (FOR SALE BY THE SUPT. OF DOCS., U.S. GOVT. PRINT. OFF., (WASHINGTON) VII, 195 P. ILLUS. 26 CM.

UNITED STATES. BUREAU OF MINES. BULLETIN 633 1.25 (PAPER COVER)
BIBLIOGRAPHY: P. 189-191. TP343 .W83 COPY 2.
LC:COAL LIQUEFACTION. COAL- ♦♦ TAR. ♦♦ HYDROGENATION.
ADDED:STORCH, HENRY HERMAN, 1894- JOINT AUTHOR.
MAIN-AUTH TRACE-SERS♦TITL♦AUTH♦ CATLG BY-LC

74V42500 1968 ISS:00 DE105.A45 NO. 430 662.66 LC-68-7898
A/RISSE, HUBERT E.

♦♦ GASIFICATION ♦♦ AND LIQUEFACTION: THEIR POTENTIAL IMPACT ON VARIOUS ASPECTS OF THE COAL INDUSTRY (BY) HUBERT E. RISSE.
ILLINOIS STATE GEOLOGICAL SURVEY, URBANA, 28 P. ILLUS., MAPS. 25 CM.
ILLINOIS. STATE GEOLOGICAL SURVEY. CIRCULAR 430 COVER TITLE.

BIBLIOGRAPHY: F. 28. ILLINOIS UNIV. LIBRARY
LC:COAL ♦♦ GASIFICATION ♦♦ -- ILLINOIS. COAL LIQUEFACTION --
ILLINOIS. COAL TRADE -- ILLINOIS.

MAIN-AUTH TRACE-SERS♦TITL♦ CATLG BY-OTHER

N69-13298# Kernforschungsanlage Juelich (West Germany)
SOME PROBLEMS OF LIGNITE GASIFICATION BY MEANS OF HIGH-TEMPERATURE NUCLEAR REACTOR HEAT
(UEBER EINIGE PROBLEME BEI DER VERGASUNG VON BRAUNKOEHLEN MIT HOCHTEMPERATUR-KERNREAKTOR WAERME)
K. Kugeler und A. T. Bhattacharyya Aug 1968 37 p refs In GERMAN
(JUL-554 RG) Avail: CFSI

A system and a facility for the generation of electric current and gas are described. Data of the speed of gasification of lignite with steam are given in addition to a description of the basic gasification reactions

Hellwig, K. C., et al, "Convert Coal to Liquid Fuels with H-Coal", Chem. Engr. Progr., Symp. Ser. V. 64, n. 85, pp. 98-103, 1968.

White, D. J., et al, "To Treat and Crack Oil from Coal", Hydrocarbon Process, V. 47, n. 12, pp. 97-102, 1968.

Cost Estimate of a 500-billion Btu/Day Pipeline Gas Plant Via Hydrogasification and Electrothermal Gasification of Lignite

Issued November, 1968

R&D Report No. 22—Interim Report No. 3

Contractor: Institute of Gas Technology

Refer to: Titled report and PB-193928

Price: \$6.00 NTIS

Project Gasoline Pre-pilot Plant—Phase I—Research on CSF Process—Volume II

Issued November, 1968

R&D Report No. 39—Interim Report No. 1

Contractor: Consolidation Coal Company

Price: \$4.50 OFFICE COAL RES.

Qader, S. A., "Production of Synthetic Fuels from Coal by Hydrogenation under Medium Pressures", Amer. Chem. Soc. Div. Fuel Chem., V. 12, n. 3, pp. 164-80, 1968.

Hydrocarbon Research, Inc., "Project H-Coal Report on Process Development", R & D Report No. 26, Contract No. 14-01-0001-47, Office of Coal Research, Wash. D. C., November, 1968.

72V23893 1967 ISS:00 TP343.H63 665.5 LC-68-66843

A/HOFFMAN; EDWARD JACK; A/1925-

WATER REQUIREMENTS FOR COAL CONVERSION (BY) E. J. HOFFMAN.

COLLEGE OF ENGINEERING, UNIVERSITY OF WYOMING (LARAMIE; 8 L. 28 CM.

UNIVERSITY OF WYOMING. NATURAL RESOURCES RESEARCH INSTITUTE.

INFORMATION CIRCULAR NO. 52 BIBLIOGRAPHY: LEAVES (7)-8.

LC:COAL ♦♦ GASIFICATION ♦♦ -- WATER-SUPPLY. COAL LIQUEFACTION

-- WATER-SUPPLY.

ADDED:WYOMING. UNIVERSITY. NATURAL RESOURCES RESEARCH INSTITUTE.

INFORMATION CIRCULAR NO. 52

MAIN-AUTH TRACE-SERS♦CORP♦TITL♦ CATLG BY-LC

1967

Commercial Process Evaluation of the H-Coal Hydrogenation Process

Issued February, 1967

R&D Report No. 26—Interim Report No. 1

Contractor: Hydrocarbon Research, Inc.

Refer to: Titled report and PB-174696

Price: \$6.00 NTIS

Char-Oil-Energy-Development—Project COED

Issued February, 1967

R&D Report No. 11—Supplement to Final Report

Contractor: FMC Corporation

Refer to: Titled report and PB-173916 (Final); Titled report and PB-173917 (Appendix)

Price: \$6.00 each NTIS

Evaluation of Project H-Coal

Issued December, 1967

R&D Report No. 32—Final Report

Contractor: American Oil Company

Refer to: Titled report and PB-177068

Price: \$6.00 NTIS

Char-Oil-Energy-Development—Project COED

Issued March, 1966

R&D Report No. 11—Final Report

Contractor: FMC Corporation

Refer to: Titled report and PB-169562 (Vol. I); Titled report and PB-169563 (Vol. II)

Price: \$6.00 each NTIS

Process Design and Cost Estimate for Production of 266 Million SCF/Day of Pipeline Gas by Hydrogasification of Bituminous Coal—Hydrogen by the Steam-Iron Process

Issued February, 1967

R&D Report No. 22—Interim Report No. 2

Contractor: Institute of Gas Technology

Refer to: Titled report and PB-174064

Price: \$6.00 NTIS

Plasma Reactions with Powdered Coal

Issued August, 1966

R&D Report No. 18—Interim Report No. 2

Contractor: University of Utah, Fuels Engineering Department

Price: \$1.00 OFFICE OF COAL RES.

72V23889 1966 ISS:00 TP343.H6 665.5 LC-68-66839
A/HOFFMAN; EDWARD JACK; A/1925-
COAL CONVERSION AND THE DIRECT PRODUCTION OF HYDROCARBONS FROM
COAL-STEAM SYSTEMS (BY) E. J. HOFFMAN.
COLLEGE OF ENGINEERING; UNIVERSITY OF WYOMING; (LARAMIE, VII; 134 L.
28 CM.

(NATURAL RESOURCES RESEARCH INSTITUTE; UNIVERSITY OF WYOMING.
INFORMATION CIRCULAR NO. 44) "A REPORT BY NATURAL RESOURCES RESEARCH
INSTITUTE." SERIES NOTE STAMPED ON T.P. BIBLIOGRAPHY: LEAVES 129-134.
LC:COAL LIQUIFICATION. COAL ♦♦ GASIFICATION: ♦♦
ADDED:WYOMING. UNIVERSITY. NATURAL RESOURCES RESEARCH INSTITUTE.
INFORMATION CIRCULAR NO. 44
MAIN-AUTH TRACE-SERS♦CORP♦TITL♦ CATLG BY-LC

73V37574 1999 ISS:00 TP759.P76 665.772 LC-73-98393
PRODUCTION OF PIPELINE GAS BY HYDROGASIFICATION OF COAL; BY E. J.
PYRCIOCH (AND OTHERS)
INSTITUTE OF GAS TECHNOLOGY; CHICAGO; V. ILLUS. 28 CM.
\$20.00 INSTITUTE OF GAS TECHNOLOGY. RESEARCH BULLETIN NO. 39 V. 1.
1954-1964.
LC:COAL ♦♦ GASIFICATION. ♦♦ HYDROGENATION.
ADDED:PYRCIOCH; E. J. CHICAGO. INSTITUTE OF GAS TECHNOLOGY. RESEARCH
BULLETIN NO. 39.
MAIN-TITL TRACE-SERS♦CORP♦AUTH♦ CATLG BY-LC

1965

Pipeline Gas from Lignite Gasification—A Feasibil-
ity Study
Issued February, 1965
R&D Report No. 16—Interim Report No. 1
Contractor: Consolidation Coal Company
Refer to: Titled report and PB-166817 (Feasibility
Study); Titled report and PB-166818 (Appendix)
Price: \$6.00 each NTIS

Process Design and Cost Estimate for Production of
265 Million SCF/Day of Pipeline Gas by Hydrogas-
ification of Bituminous Coal
Issued October, 1965
R&D Report No. 22—Interim Report No. 1
Contractor: Institute of Gas Technology
Refer to: Titled report and PB-176982
Price: \$6.00 NTIS

293

HYDROREFINING COAL-OILS TO FUELS FOR SUPERSONIC AIRCRAFT.

C.O. Hawk, M.D. Schlisinger, P. Dobransky and R.W. Hiteshue.

Bureau of Mines RI-6655 1965

Distillable oils derived from coal were desulfurized and hydrogenated at 2,500 psig in a two-step vapor-phase catalytic operation to give a product rich in saturated cyclic hydrocarbons. The first step was mainly a desulfurization at 400° C, the second a saturation at 300° C. One of the oils used as feed stock was from low-temperature carbonization of a bituminous coal, the other was from the liquid-phase hydrogenation of coal in the Bureau's pilot plant. The product from the saturation step was distilled to remove the light ends and high-boiling residue and to recover a fraction having acceptable properties with respect to heating value, density, freezing point, viscosity, and boiling range according to specifications suggested by the Air Force for ultra-high-speed aircraft fuel. Quantities of the fuel fraction available were too small for the thermal stability test approved by the Air Force.

(SLA-73-6002) HYDRAULIC FRACTURING FOR UNDERGROUND GASIFICATION OF COAL DEPOSITS. Klimenkov, P. P. Translated from Izv. Vyssh. Ucheb. Zaved., Geol. Razved., No. 10, 97-105(1964). 21p. Dep. NTIS \$3.25.

Hydraulic fracturing was applied as a possible means of shaftless preparation of coal seams for underground gasification in the USSR at the "Podzemgas" station at Lisichansk in 1953. The initial fracturing agent was air injected under high pressure, but later a trial was carried out on connecting vertical boreholes with an inclined path by breaking through the dividing coal section with water pumped in under pressure. The parameters of variations of the original method were discussed. Practice shows that the effectiveness of hydraulic fracturing of formations depends on the strength properties of the formations and on the technology applied. Results from using various liquids are given. Data include information on water, oil-based fluids, and water and sand combinations. (MCW)

1964
CX-140,416
HYDROGASIFICATION OF HIGH-VOLATILE A BITUMINOUS COAL. Raymond W. Hiteshue, Sam Friedman, and Robert Madden. 1964. 31p.

Bureau of Mines RI 6376

CX-140,618
(1961)
SYNTHETIC FUEL FROM COAL FOR SUPERSONIC AIRCRAFT. M.D. Schlesinger and R.W. Hiteshue. (June 1961). 19p.

Bureau of Mines RI 5902

1974

SHALE OIL—NOT LONG NOW.

G.E. Weismantel.

Chem. Eng., v.81, no.10, May 13, 1974, p.62, 64.

As the U.S.'s prototype leasing program for oil-shale lands nears completion, various processing schemes are jockeying for position, and a number of nontechnical problems are emerging.

SHALE GASIFICATION UNDER STUDY.

F.C. Schora, Jr., et al, Inst. Gas Technology.
Hydrocarbon Process, v.53, no.4, Apr. 1974,
p.89-91.

SHALE OIL—PROCESS CHOICES.

Chem. Engineering, v.81, no.10, May 13, 1974,
p.66, 68, 69.

Here's a rundown on some of the routes being groomed for production of shale oil. One of these, the Tosco II process, is already considered proven and is on the verge of commercialization.

1974

OIL SHALE AND THE ENERGY CRISIS.

G.U. Dinneen and G.L. Cook.

Technology Review, Jan. 1974, p.27-33.

As energy becomes more costly the temptations grow and commercial use of oil shale nears; but substantial technological and environmental problems remain.

OIL FROM ROCKS: WORK BEGINS IN EARNEST.

U.S. News & World Report, Jan. 28, 1974, p.70.

A first and vital step has been taken toward mass production of fuel from America's vast deposits of oil shale.

INDUSTRY GEARING UP FOR ASSULT ON ATHABASCA TAR SANDS.
Oil & Gas Journal, v.72, no.5, Feb. 4, 1974, p.85, 86,
90.

Northeastern Alberta's tar sands hold 26.5-billion bbl of synthetic-crude reserves recoverable by a proved process.

1974

(Y-1922) REPRODUCIBILITY AND THERMAL STABILITY OF COAL-TAR PITCH. Smith, W. E.; Horne, O. J.; Napier, B. (Oak Ridge Y-12 Plant, Tenn. (USA)). 1 Feb 1974. Contract W-7405-eng-28. 15p. Dep. NTIS \$4.00.

Two aspects of a coal-tar pitch were studied: (1) reproducibility of the properties of as-received pitch as a function of the sampling period, and (2) changes in the properties that occur on heating the pitch for extended periods at elevated temperature. Reproducibility studies were conducted on twelve samples which had sampling histories that divided them into two groups of six samples each. Data indicated little variability of properties within a sample group, but significant variability between the two groups. A single lot of coal-tar pitch was analyzed as a function of residence time in an impregnator at 235°C. Properties reflecting increasing heating time, but the overall changes after 88 days did not appreciably alter the properties or utility of the pitch. (auth)

AT LAST, CANADA'S TAR SANDS LOOK ECONOMIC.
Business Week, Jan. 5, 1974, p. 42-43.

The pressure is mounting to tap the vast reserves of oil locked in Alberta.

PROCESS AND APPARATUS FOR OIL SHALE RETORTING. Frick, G. W. (to Cities Service Research and Development Co.). US Patent 3,784,462. 8 Jan 1974. Filed date 25 Feb 1971. 6p.

A process and apparatus are disclosed for the continuous steady state retorting of ground oil shale in the absence of air. Retorting is accomplished by countercurrently contacting heated spent oil shale with fresh ground oil shale in a vessel from which air is excluded. The spent oil shale is heated by combustion of its carbonaceous residue to form a hot heat transfer medium which, when contacted with fresh oil shale in the retorting process, provides the energy for the recovery of hydrocarbons. (auth)

1974

Some Effects of Pressure on the Hydrocracking of Crude Shale Oil Cobalt Molybdate Catalyst.

C. M. Frost, and P. L. Cottingham.
Bureau of Mines, Washington, D.C. Jan 74. 16p BuMinRes RI-7835

PB-229 482/SWE: PC\$3.00/MF\$1.45

Crude shale oil produced by gas-combustion retorting of Green River oil shale was hydrocracked over a cobalt molybdate catalyst at operating pressures of 500, 1,000, 1,500, and 3,000 psig, an operating temperature of 890°F, and a liquid hourly space velocity of 1.0. Hydrogen feed rate was maintained at 6,000 scf/bbl. The volume-percent yields of total liquid product were directly proportional to the operating pressure. Weight-percent conversion and volume-percent yields of gasoline were directly proportional to the log of the operating pressure. Catalyst deposit percentages were inversely proportional to the log of the operating pressure. Nitrogen and sulfur removal rates as well as saturation of the liquid products increased as the operating pressure was increased. (Author)

DRIVE FINALLY BUILDING IN U. S. TO DEVELOP OIL SHALE. West, J. Oil Gas J.: 72: No. 8, 15-19/25 Feb 1974.

The U. S. will be producing about 1 million bbl/day of shale oil generally regarded as a mature level of development, in the 1980's barring problems with technology, capital, manpower, availability of federal leases, and environmental concerns. Geologists believe shale-oil deposits in the Tertiary Green River formation in the tri-state region of Colorado, Utah, and Wyoming hold promise for commercial production. Many oil companies are exploring in northwestern Colorado's Piceance Basin. Plans for all the oil companies are told, but Superior Oil Co. believes its plant could produce low-sulfur No. 6 fuel oil, naphcolite, aluminum compounds, and sodium carbonate. Naphcolite may be converted to soda ash and used in conjunction with a particulate-removal device to scrub stack gas to meet environmental controls. (MCW)

Oil Shale. A Bibliography with Abstracts.

Axel C. Ringe.

National Technical Information Service, Springfield, Va. Jun 74. 94p NTIS-WIN-74-040

COM-74-10969/5WN PC\$20.00/MF\$20.00

This bibliography contains 89 selected abstracts of research reports retrieved using the NTIS on-line search system--NTISearch. The reports selected cover all phases of oil shale research, including exploration, mining, retorting, chemistry, environmental impacts, and policies.

293

OIL SHALE: A CLEAN ENERGY SOURCE --- AND ITS ENVIRONMENTAL EFFECTS
A/KATELL, S.; B/STONE, R.; C/WEELMAN, P.
BUREAU OF MINES, MORGANTOWN, W.VA. AVAIL.NTIS HC \$4.50
PRESENTED AT THE 18TH ANN. MEETING OF THE AM. ASSOC. OF COST
ENGR., LOS ANGELES, 30 JUN. - 3 JUL. 1974
/♦ENVIRONMENT EFFECTS/♦SHALE OIL/ ENERGY SOURCES/ ENERGY TECHNOLOGY/
INDUSTRIES

1974

OIL SHALE: A HUGE RESOURCE OF LOW-GRADE FUEL.
W.D. Metz.
Science, v.184, June 1974, p.1271,72,74,75.

The rich oil shale deposits on the western slope of the Rocky Mountains constitute a potential source of fuel several times as great as the identified reserves of US oil, and processes for extracting synthetic crude oil from the thick seams of brown-black rocks have been ready to go for 15 years.

Nature, v.249, June 21,1974, p.704-706.

Huge resources needed to exploit shale oil

Colin Norman

Nature, 711 National Press Building, Washington DC, 20004

Although there is plenty of shale oil in the United States, treatment at the surface of the rock that contains the oil would require prohibitive amounts of water. But the alternative, production in situ, is not yet a well-developed technique.

GREEN RIVER SHALE-OIL YIELDS: CORRELATION WITH ELEMENTAL ANALYSES. Cook, E. W. (Rocky Flats Research Centre, Golden, CO). Fuel; 53: No. 1, 16-20 (Jan 1974).

A rapid and practical test for oil-shale richness is of considerable technical importance. Although the Fischer-Schrader method has gained universal acceptance for determination of shale richness, there is need to relate results from this determination to fundamental parameters of the shale. One much-used relation is with elemental analysis, and numerous equations have been derived to correlate shale richness with organic carbon content. These relations have been reviewed, and from a number of intensively analysed samples selected from a coring in the Parachute Creek member of the Green River Formation equations relating oil yield by Fischer-Schrader determination to organic carbon content have been developed: oil (wt %) = $0.8317(\%C_{org}) - 0.2509$ and oil (gal/ton) = $2.216(\%C_{org}) - 0.7714$. Additionally, more detailed knowledge of the uniformity of organic material throughout the Green River Formation was obtained. It was found that the fraction of kerogen which on pyrolysis yields liquid products is constant stratigraphically throughout the formation, even though the oil composition is not. 26 references. (auth)

DRIVE FINALLY BUILDING IN U.S. TO DEVELOP OIL SHALE.

J. West.

Oil & Gas Jour, v.72, no.8, Feb.25,1974, p.15-19.

Energy prices are high enough to support a drive to tap vast deposits of shale oil locked in a three-state region of the Rocky Mountains.

OXIDATION OF BITUMEN IN RELATION TO ITS RECOVERY FROM TAR-SAND FORMATIONS. Moschopedis, S. E.; Speight, J. G. (Research Council of Alberta, Edmonton). Fuel; 53: No. 1, 21-25 (Jan 1974).

Simple chemical reactions are described that bring about modification of the components of a bitumen. This is accomplished by using an oxygen-containing gas and subsequent treatment with alkali solutions of sulfites and/or bisulfites. The resulting water-soluble sulfonated bituminous derivatives have significant emulsifying and dispersing powers and are likely to be of use in extracting the bitumen *in situ*. (auth)

UCRL-75242 (Rev. 1) OUTLOOK FOR OIL SHALE. Lewis, A. E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 25 Feb 1974. 13p. (CONF-740213-2). Dep. NTIS \$4.00.

From 140th meeting of The American Association for the Advancement of Science; San Francisco, California, USA (25 Feb 1974).

The extent to which oil from domestic oil shale will provide energy in the future depends as much on national and regional political decisions, as it does on technical or economic issues. Technology available to industry in this decade can be used to ensure a modest supply of oil from oil shale at present prices and with a total reserve of about 54 billion barrels of oil, if some government land is made available and environmental requirements are defined. The capability of developing technology within this decade to produce oil in large enough quantity and at low enough cost to exert a major influence on the national and international oil market exists. *In situ* processes and/or massive open-pit technology would open up a much larger resource (200 to 800 billion barrels) within a small area (600 mi²) of Colorado. Development of this technology is beyond the capability of industry alone and will require a definition of the role of government and industry in the planning, management, production, and ownership of the resource. (auth)

RESEARCH ON THERMAL BEHAVIOR OF OIL SHALES.

Nistor, I.; Barza, F.; Cornica, E.; Bihulescu, A. Stud. Cercet. Energ. Electroteh.; 23: No. 4, 911-917 (1973). (In Rumanian).

For the characterization of the thermal behavior of the organic and inorganic mass of oil shales research was carried out with the aid of a derivatograph on the material itself and on the residue resulting from the extractions with pyridine and quinoline in oxidizing, reducing and inert medium. The exothermal and endothermal zones and resulting weight losses were determined. The correlation of the experimental data shows that the oil shale burning takes place in a relatively low temperature domain. (tr-auth)

ALABAMA TAR SANDS PROJECT, 1972. Moffat, I.; Boone, P. A. Tuscaloosa, AL: University of Alabama (1973). 59p. \$13.45.

A research study of tar sands in Colbert, Franklin, Lawrence, and Morgan counties in Alabama was carried out in 1972. Fieldwork included geologic mapping of the Hartsville Sandstone of Mississippian age and its oil impregnated intervals, sampling along the outcrop of the impregnated zones, and analysis to determine the porosity, permeability, and hydrocarbon saturation. Seven core holes were drilled down dip from the outcrop of the oil-impregnated sandstone and then analyzed. Hydrocarbon reserves were calculated from the analyses resulting in the conclusion that within an area of 32,000 acres there are about 150 million barrels of oil impregnated in the sandstone. Appendix A includes measured sections data; Appendix B includes Alabama tar sands core holes data; and Appendix C is the Shell Oil Company core holes data. Five maps or plates are locations of measured sections; oil saturation; total thickness of oil impregnated sand; possible oil reserves; and a generalized geologic map of Morgan County and parts of Lawrence County. (MCW)

COM-73-11591/SCA PC\$20.00/MFS20.00
National Technical Information Service, Springfield, Va.
OIL SHALE. A BIBLIOGRAPHY WITH ABSTRACTS
Rept. for 1964-May 73,
Axel C. Ringe. Aug 73, 65p* NTIS-WIN-73-030
Supersedes NTIS-PK-107.

Descriptor: (*Oil shale, *Bibliographies). Fossil fuel deposits, Geophysical prospecting, Beneficiation, Geology, Mineral economics, Environmental surveys, Fuels, Oil recovery, Mining, Hydrocarbons.
Identifiers: Nahcolite, Dawsonite.

NTISearch bibliography contains 60 selected abstracts of research reports retrieved using the NTIS on-line search system--NTISearch. The reports selected cover all phases of oil shale research, including exploration, mining, retorting, chemistry, environmental impacts, and policies. (Author)

Refining Improvement of Shale-Oil Naphtha Bureau of Mines, Wash., D.C.

Gives results of tests conducted to determine how much improvement would be made by subjecting hydrogenated shale oil naphtha to a catalytic reforming process. April 1973. 20 pp. PC \$3/MF \$1.45 order PB-220-585

U. S. Energy Outlook: Oil Shale Availability.
1973. National Petroleum Council, 1625 K Street, N.W., Washington, D. C. 20006. 87 pp., paper. \$8.00.

This is one of a series of reports by the committee on U. S. energy outlook of the National Petroleum Council. It is divided into the following sections: (1) introduction, (2) supply elasticity, (3) effect of government policies and legislation, (4) changes in technology and the learning-curve effect, and (5) regional considerations for direct support of an oil-shale industry.

N74-15260 Geological Survey, Washington, D.C.

OIL SHALE

William C. Culbertson and Janet K. Pitman. In its US Mineral Resources 1973 p 497-503 refs (For availability see N74-15214 06-18)

Oil shale is a fine-grained sedimentary rock containing organic matter that has the property of yielding substantial amounts of oil when heated in a closed retort (destructive distillation) but that is mostly insoluble in ordinary petroleum solvents. The United States has tremendous quantities of oil shale, principally in the Green River Formation in Colorado, Utah, and Wyoming. These three States contain identified resources of about 1.8 trillion barrels of oil in oil shale that yields an average of 15 or more gallons per ton. However, no oil-shale venture has been a commercial success in the United States in the last 100 years, despite the fact that other countries of the world have for many years burned oil shale as a fuel, or have produced oil or combustible gas from the shale.

Author

N74-15226 Geological Survey, Washington, D.C.

BITUMEN-BEARING ROCKS

W. B. Cashion. In its US Mineral Resources 1973 p 99-104 refs (For availability see N74-15214 06-18)

Bitumen bearing rocks occur in many areas in the United States, but few deposits have been exploited or evaluated for their total energy potential. The evaluated deposits are a relatively small part of North American resources of bitumen bearing rocks and probably will not contribute to U.S. energy needs before 1985. Studies of known but unappraised deposits, especially extensive subsurface tar sands, will greatly increase total resource estimates. Technological advancements are needed in tar sand processing, especially for in situ recovery methods.

Author

N74-19047# Sandia Labs., Albuquerque, N.Mex.
FRACTURE OF COAL AND OIL SHALE FOR IN SITU PROCESSING OR REMOTE REMOVAL: A PROPOSAL SUPPORT DOCUMENT

L. D. Tyler and W. D. Wear. Oct. 1973 17 p refs (Contract AT(29-1)-789) (SLA-73-946) Avail: NTIS HC \$3.00

The proposal sets forth the concept of using the synergistic effects of a combination of hydraulic and explosive techniques to fracture these formations in a controlled manner.

Author (NSA)

AICHE Symposium Series, v.69, no.127 1973

DECLINING DOMESTIC RESERVES - EFFECT ON PETROLEUM
AND PETROCHEMICAL INDUSTRY. C.H. Cummings, ed.
(Contains papers presented at the 71st National
Meeting of AIChE, Dallas, (Tex., 1973)).

American Inst. of Chemical Engineers

OUTLOOK FOR CANADIAN OIL SANDS DEVELOPMENT	J. D. Harvie, J. H. Nichols, and A. G. Winestock	30
OUTLOOK FOR HYDROCARBON PRODUCTION FROM DOMESTIC OIL SHALE, COAL, AND TAR SANDS	J. Wade Watkins, G. Alex Mills, and Jack E. Phillips	32

PILOT PLANT STUDY OF THE ENGINEERING ASPECTS OF RETORTING OIL SHALE IN A NUCLEAR CHIMNEY	H. W. Sohns, A. E. Harak, and H. C. Carpenter	50
ENGINEERING ASPECTS OF PROCESSING OIL SHALE BY IN SITU RETORTING	Harry C. Carpenter, Edward L. Burwell, and Harold W. Sohns	96
MANUFACTURE OF LOW SULFUR FUEL OILS FROM OIL SHALE.	R. H. Smith	98

OIL SHALE IN THE ENERGY WINGS. Pub. Util.
Forum.; 92; No. 10, 66-66(8 Nov 1973).
The world's largest oil shale reserves are found in the Green
River formation of Colorado, Utah, and Wyoming, containing an
estimated 1.8 trillion barrels of oil, of which approximately
600 billion barrels can be developed with the present technology.
Crude shale oil can be hydrotreated at the mine site. As a pre-
mium fuel oil it either can be blended with high sulfur stocks to
yield fuels meeting environmental specifications or can be used
as fuel for stationary gas turbine plants. As a premium feedstock
it can be used to produce gasoline and fuel oils in a simple, low-
cost refinery operation. Hydrotreated shale oil naphtha can be
marketed as a feedstock for SNG manufacture. (MCW)

PG-224 602/3GA PC33.50/MF31.45
Bureau of Mines, Washington, D.C.
IN SITU RETORTING OF OIL SHALE
RESULTS OF TWO FIELD EXPERIMENTS.
Report of Investigations,
E. L. Burwell, T. E. Sterner, and H. C. Carpenter.
Sep 73, 47p. BuMines RI-7783
Prepared by Laramie Energy Research Center,
Wyo.

Descriptors: (*Oil shale, *In situ combustion),
Shale oil, Oil recovery, Wyoming, Yield.
Application of the in situ recovery process to oil
shale was tested during two field experiments near
Rock Springs, Wyo. The results of these tests
demonstrated that a self-sustaining combustion
zone can be created in an oil shale body, that this
zone can be moved through the oil shale, and that
the process will produce shale oil. Evaluation of
the combustion process by monitoring produced
fluids for physical and chemical properties and
volumes is described. The material and energy
balance obtained is compared with a second
evaluation based on extensive coring of the test
area after the test was terminated. Several side
results of the research are noted such as ground
surface heating by underground burning and
production of low to medium Btu gas during re-
torting. (Author)

TITLE: Nuclear In Situ Recovery of Oil From Oil
Shale

AUTHOR: Lewis, A.E.

CORPORATE AUTHOR: Lawrence Livermore Laboratory
Address: University of California, Livermore, Ca

PUBLICATION DESCRIPTION: Report No. UCRL-51453,

94550

54 p., 42 references

PUBLICATION DATE: 1973, September 14

SPONSOR: U.S. Atomic Energy Commission

ABSTRACT: A plan is presented for production of

oil by retorting oil shale in situ after

breaking it with underground nuclear

explosives. Reserves of oil shale of

thickness and grade suitable (greater than 20

gal/ton) for this process occur in the

Piceance Creek Basin of Colorado, and are

estimated to contain 640 billion barrels of

oil in place. Cost projections indicate that

this oil could be produced at a price ranging

from \$2.00 to \$3.30 at the wellhead with a

20% rate of return on investment (discounted

cash flow). The price and production rate

vary with oil shale thickness. At a rate of

32 nuclear chainings per year in oil shale

ranging in thickness from 1000 to 2000 ft,

production varies from 28 million bbl/yr

(\$3.30/bbl) to 121 million bbl/yr

(\$2.00/bbl). Capital requirements for this

in situ process are estimated to be 20 times

less than those required by a surface

retorting process. Environmental problems

such as the need to dispose of large volumes

of waste rock associated with conventional

mining and surface retorting of oil shale

would be largely avoided. Problems of seismic

ground motion and possible contamination of

the oil and groundwater appear manageable.

The necessity for government action arising

from federal ownership of the resource as

well as the requirement for a significant

government contribution to the development of

the nuclear in situ retorting technology

requires either government development of the

resource or a policy defining how industry

and government may jointly develop it. The

potential contribution to the energy

resources of the nation is so large that this

method of recovery from oil shale must be

considered. (auth)

AVAILABILITY: NTIS (53.05)

1973

N73-29387# Interior Dept., Washington, D.C.
**ENVIRONMENTAL STATEMENT FOR THE PROPOSED
PROTOTYPE OIL-SHALE LEASING PROGRAM. VOLUME 1:
DESCRIPTIONS OF THE REGIONS AND POTENTIAL
ENVIRONMENTAL IMPACTS**

Sep. 1972 501 p refs

(EIS-AA-72-5242-D-1-Vol-1) Avail: NTIS HC \$27.25
The regional environmental impact expected from shale development on private and public lands is examined. A companion document reviews the specific impacts associated with the development of six leases on public lands if the Department of the Interior's proposed prototype oil shale leasing program is implemented. A current state-of-the-art assessment of the technology that may be employed in oil shale development is provided. Included in this assessment are methods of processing; technology related to the management of solid wastes and wastes within the working areas; monitoring methods; and a guide to current research that pertains to the environmental aspects of oil shale development. The regional environmental impact of 1 million barrels per day by 1985 is described. Author

N73-29388# Interior Dept., Washington, D.C.
**ENVIRONMENTAL STATEMENT FOR THE PROPOSED
PROTOTYPE OIL-SHALE LEASING PROGRAM. VOLUME 2:
ENERGY ALTERNATIVES**

Sep. 1972 228 p refs

(EIS-AA-72-5242-D-2-Vol-2) Avail: NTIS HC \$13.50
This section of the environmental impact statement discusses energy alternatives to the proposed action cast in the framework of the Proposed Prototype Oil-Shale Leasing Program. This prototype plan anticipates six test leases, two each in the States of Colorado, Utah, and Wyoming, and a program that might lead to a maximum total production of 1 million barrels of shale oil per day by the year 1985 from both public and private lands. This document discusses: (1) energy situation; (2) role of energy in economic growth; (3) energy requirements of the U.S. to meet projected future needs; (4) substitutability of energy forms; (5) factors that affect fuels development; (6) background of petroleum situation, both present and future; (7) oil-shale development possibilities; and (8) alternatives to the Proposed Prototype Oil-Shale Leasing Program. Author

N73-29389# Interior Dept., Washington, D.C.
**ENVIRONMENTAL STATEMENT FOR THE PROPOSED
PROTOTYPE OIL-SHALE LEASING PROGRAM. VOLUME 3:
DESCRIPTION OF PROPOSED PROTOTYPE LEASES AND
POTENTIAL ENVIRONMENTAL IMPACTS**

Sep. 1972 359 p refs

(EIS-AA-72-5242-D-3-Vol-3) Avail: NTIS HC \$20.00
Specific impacts associated with the development of up to six tracts which, if implemented, would be offered for development under the Department of the Interior's proposed prototype oil shale leasing program are discussed in detail. Author

293

1972

74V29822 1972 ISS:00 TP343.R33 0-815504-45-4 662.669 LC-77-180879
 A/RANNEY, MAURICE WILLIAM, A/1934-
 LIQUID FUELS FROM ♦♦ OIL ♦♦ ♦♦ SHALE ♦♦ AND ♦♦ TAR ♦♦
 SANDS, 1972 (BY) JOHN McDERMOTT.
 NOYÉS DATA CORP. PARK RIDGE, N.J.; VII; 276 P. ILLUS. 28 CM.
 CHEMICAL PROCESS REVIEW NO. 65 \$36.00
 LC:LIQUID FUELS -- PATENTS. SHALE OILS -- PATENTS.
 MAIN-AUTH TRACE-SER3+TITL+ CATLG BY-LC

1972

1972

TITLE: Oil Shale - A Statewide Answer to

Petroleum Shortage

CORPORATE AUTHOR: Mining Engineering

ADDRESS: 385 E. 47th St., New York, NY 10017

PUBLICATION DESCRIPTION: Mining Engineering,

24(10), 95-98

PUBLICATION DATE: 1972, October

ABSTRACT: A summary of the largest development of oil shale in this country is given. This location is in western Colorado on privately owned land. Larger reserves exist on Federal lands. The history, the Oil Shale Corporation (TOSCO) process, the mining methods, the waste disposal, and the land status are described. (JMC)

TITLE: The New Look in the Syncrude Canada Tar

Sands Project

AUTHOR: Spragins, F.R.

CORPORATE AUTHOR: Syncrude Canada Ltd.

ADDRESS: Edmonton, Alberta, Canada

PUBLICATION DESCRIPTION: Mining Engineering,

24(10), 90-92

PUBLICATION DATE: 1972, October

ABSTRACT: The Athabasca tar sands in Alberta, Canada, are a rich potential source of synthetic crude oil. The Great Canadian Oil Sands plant is currently producing 99,000 barrel/day of crude oil and a proposed Syncrude plant will produce 125,000 barrel/day. The two processes differ in details of operation. (JMC)

Canada's tar sands next

Am., Pet. Press Service, 39, (12), 451-453, (Dec. 1972). The rapidly rising price of oil has so improved the economics of producing synthetic crude at Athabasca that large-scale development of Canada's tar sands now looks certain. A description is given of the efforts of the Great Canadian Oil Sands company to produce and sell synthetic crude and of projects proposed by other companies including the Syncrude consortium, Shell, Amoco, Texaco, and BP. DTI

203

73V35791 1970 ISS:00 TN873.C2C3 LC-73-23431
 A/CAMP; FREDERICK W., A/1934-
 THE ♦♦ TAR ♦♦ SANDS OF ALBERTA; CANADA (BY) FREDERICK W. CAMP.
 CAMERON ENGINEERS (DENVER) 78 P. ILLUS.; MAPS. 27 CM.
 BIBLIOGRAPHY: P. 73-78.
 LC: ♦♦ OIL ♦♦ SANDS -- ALBERTA.
 ADDED:N♦CN♦AB
 MAIN-AUTH TRACE-TITL♦ CATLG BY-LC

TYPE 14/2/5

74V17032 1969 ISS:00 TN295.U♦ NO. 8429 622.08 S LC-74-605044
 A/ROGERS; MARIANNE P., A/1934-
 LIST OF BUREAU OF MINES PUBLICATIONS ON ♦♦ OIL ♦♦ SHALE
 ♦♦ AND ♦♦ OIL, ♦♦ 1917-68. COMPILED BY MARIANNE P.
 ROGERS.
 U.S. BUREAU OF MINES; (FOR SALE BY THE SUPT. OF DOCS.; U.S. GOVT.
 PRINT. OFF.; (WASHINGTON) 61 P. 26 CM.
 UNITED STATES. BUREAU OF MINES. INFORMATION CIRCULAR 8429 0.65 BASED
 ON WORK DONE IN COOPERATION WITH THE UNIVERSITY OF WYOMING.
 LC: ♦♦ OIL-SHALES ♦♦ -- BIBLIOGRAPHY. ♦♦ SHALE ♦♦ OILS --
 BIBLIOGRAPHY.
 ADDED:WYOMING. UNIVERSITY.
 MAIN-AUTH TRACE-SERS♦CORP♦TITL♦ CATLG BY-LC

72V36706 1968 ISS:00 TN859.C3A2 553.209715 LC-70-535336
 A/ABBOTT, D.
 COMPOSITION OF ♦♦ OIL ♦♦ SHALE ♦♦ AND COAL ASHES, NEW
 BRUNSWICK (BY) D. ABBOTT (AND) D. E. BARNETT.
 NBRPC MINERALS & MATERIAL SCIENCES DEPT.; FREDERICTON, 12 P. COL.
 MAP. 25 CM.
 NEW BRUNSWICK RESEARCH AND PRODUCTIVITY COUNCIL. RESEARCH NOTE, 14
 BIBLIOGRAPHY: P. 12.
 LC: ♦♦ OIL-SHALES ♦♦ -- NEW BRUNSWICK. COAL -- NEW BRUNSWICK.
 ADDED:N♦CN♦NK BARNETT, D. E.; JOINT AUTHOR.
 MAIN-AUTH TRACE-SERS♦TITL♦AUTH♦ CATLG BY-LC
 / / PUBL IN CANADA

72V22776 1968 ISS:00 TN23.U4 NO. 633 662.6622 LC-68-62084

R/WU; WILLIAM R. K.
HYDROGENATION OF COAL AND TAR, BY W. R. K. WU AND H. H. STORCH.
U.S. DEPT. OF THE INTERIOR; BUREAU OF MINES; (FOR SALE BY THE SUPT.
OF DOCS.; U.S. GOVT. PRINT. OFF.; (WASHINGTON) VII; 195 P. ILLUS. 26
CM.

UNITED STATES. BUREAU OF MINES. BULLETIN 633 1.25 (PAPER COVER)
BIBLIOGRAPHY: P. 189-191. TP343 .W83 COPY 2.
LC: COAL LIQUEFACTION. COAL-TAR. HYDROGENATION.
ADDED: STORCH; HENRY HERMAN; 1894- JOINT AUTHOR.
MAIN-AUTH TRACE-SER3+TITL+AUTH+ CATLG BY-LC

74V22689 1967 ISS:00 JX1977.A2ST/ECA/101 553.8 LC-76-4044
UTILIZATION OF ♦♦ OIL ♦♦ ♦♦ SHALE! ♦♦ PROGRESS AND
PROSPECTS.

UNITED NATIONS. DEPT. OF ECONOMIC AND SOCIAL AFFAIRS.
NEW YORK; VIII; 112 P. ILLUS.; MAPS. 28 CM.
{UNITED NATIONS. DOCUMENTS} ST/ECA/101 2.00 "UNITED NATIONS
PUBLICATION. SALES NO.: 67. II.B. 20." INCLUDES BIBLIOGRAPHIES.
LC: ♦♦ OIL-SHALES. ♦♦ ♦♦ OIL-SHALE ♦♦ INDUSTRY.
MAIN-CORP TRACE-SER3+TITL+ CATLG BY-LC

72V30056 1967 ISS:00 TN858.C34 553.2 LC-70-18562
♦♦ OIL ♦♦ ♦♦ SHALE! ♦♦ A NEW POTENTIAL FUELS INDUSTRY.
PREPARED FOR ANDRESEN AND COMPANY.
CAMERON AND JONES, INC.; DENVER.
DENVER; 94 P. ILLUS. (PART FOLD.; PART COL.) 29 CM.
LC: ♦♦ OIL-SHALES. ♦♦
ADDED: ANDRESEN AND COMPANY.
MAIN-CORP TRACE-CORP+ CATLG BY-LC

73V39108 1966 ISS:00 TN24.N6A235 NO. 87 LC-73-153295 TN859.U52
PRELIMINARY INVESTIGATIONS OF THE ♦♦ OIL ♦♦ ♦♦ SHALE ♦♦
POTENTIAL IN NEW MEXICO; BY ROY W. FOSTER (AND OTHERS)
STATE BUREAU OF MINES AND MINERAL RESOURCES; SODORRO, N.M.; 21; (1)
P. MAPS (PART COL.) 28 CM.
NEW MEXICO. BUREAU OF MINES AND MINERAL RESOURCES. CIRCULAR 87
BIBLIOGRAPHY: P. (22)
LC: ♦♦ OIL-SHALES ♦♦ -- NEW MEXICO.
ADDED: N+US+NM FOSTER; ROY W.
MAIN-TITL TRACE-SER3+AUTH+ CATLG BY-LC

C. HYDROGEN AND METHANOL

HYDROGEN

Hydrogen Energy. A Bibliography with Abstracts. Cumulative
Volume 1953 Through 1973.

Kenneth E. Cox.

New Mexico Univ., Albuquerque. Technology Application
Center. 1 Jan 74, 634p TAC/H-74-500

PB-230 845/0WE PCS25.00/MF\$25.00;Foreign

PCS27.50/MF\$27.50

Modern computerized literature search techniques were used
to compile this extensive bibliography with abstracts on all
aspects of the 'Hydrogen Economy'. This bibliography seeks,
as its main goal, to cover the topic of hydrogen as an energy
carrier. Topics discussed include the following: General;
production; utilization; transmission, distribution and storage;
safety.

HYDROGEN AND ENERGY.

C. Massetti.

Entropie, no.55, Jan./Feb.1974, p.15-19.
(In French)

*Hydrogen, which is already used through
chemically bonded forms by the ton in
petroleum and petrochemical industries
could become in the future the energetic
support complementary to electricity.
However its generalized use will make
sense only if it can be produced in accep-
table yields from fusion, nuclear, or
solar energy in a safe non polluting way.
These conditions involve important tech-
nological new developments with a large
impact since it means not less than the
substitution of all uses of hydrocarbon
fossils. The new prices of crude oils (this
paper was written in Novembre 1973)
give more importance still to this techno-
logical challenge.*

THE WIND OF HYDROGEN AND OF CHANGE BLEW GENTLE,
CLEAN, AND PERSISTENT AT MIAMI.....

R.W. Cahn.

Nature, v.248, no.5450, Apr.19,1974, p.628,629.

Professor Cahn, of the School of Applied Sciences,
Univ. of Sussex, gives his impressions of a recent
conference on the Hydrogen Economy held in Miami.

HYDROGEN ECONOMY CONCEPT GAINS CREDENCE.

(Report from the Miami Conference)

Chem. Eng. News, v.52, no.13, Apr.1974, p.15-19.

THE HYDROGEN ECONOMY MIAMI ENERGY (THEME) CONFERENCE.

Presented by The School of Engineering &
Environmental Design, Univ. Miami, Coral
Gables, Florida.
Sponsored by The National Science Foundation,
Defense Advanced Research Projects Agency,
and The School of Continuing Studies, Univ.
of Miami.

Miami Beach, Florida, Mar. 18-20, 1974.

THE ENERGY CRISES

F. Schulman, Fred Schulman Associates, Silver
Spring, Maryland

THE HYDROGEN ENERGY ECONOMY - A TECHNOLOGY ASSESSMENT

E. Dickson, T. Logothetti, T. Lyman, L. Weis-
becker, Stanford Research Institute, Menlo Park,
California

HYDROGEN: MECHANISMS AND STRATEGIES OF MARKET PENETRATION

C. Marchetti, Euratom, Ispra, Italy

FUTURE UNITED STATES ENERGY DEMAND PATTERNS AND THE USE OF HYDROGEN

L. Blank, University of Texas, R. Riley, University
of Missouri, Rollo, Missouri

TECHNICAL PROBLEMS FACING THE HYDROGEN ECONOMY

D. Gregory, Institute of Gas Technology, Chicago,
Illinois

HYDROGEN - THE ULTIMATE ENERGY SOURCE

J. G. Hirschberg, University of Miami, Coral
Gables, Florida

SOCIAL AND ENVIRONMENTAL CONTEXT OF THE HYDROGEN ECONOMY

J. D. Salmon, Virginia Polytechnic Institute and
State University, Blacksburg, Virginia, J. G.
Wittwer, University of Oklahoma, Norman
Oklahoma

ENVIRONMENTAL IMPACT OF A SUITABLE NUCLEAR POWER REACTOR USED TO PROVIDE A PROCESS HEAT SYSTEM TO SYNTHESIZE FUELS

J. A. Richardson, Burns and Roe, Inc., Oradell,
New Jersey

OCEAN SITING FOR HYDROGEN POWER PLANTS

G. Rothwell, I. Yumori, Y. Yamashita, S. Rib-
koff, D. Wilson, Oceanic Institute, Waimanalo,
Hawaii

HOW MIGHT THE HYDROGEN ECONOMY EFFECT OUR RESOURCES AND ENVIRONMENT?

H. Plass, University of Miami, Coral Gables,
Florida

H₂-O₂ COMBUSTION POWERED STEAM-AND CENTRAL POWER SYSTEMS

G. R. Seikel, J. M. Smith, L. D. Nichols, National
Aeronautics and Space Administration, Lewis
Research Center, Cleveland, Ohio

THE HYDROGEN ECONOMY AND THE LAW

T. C. Cady, West Virginia University, Morgantown,
West Virginia

NUCLEAR ENGINEERING IMPACT UPON THE HYDROGEN ECONOMY

J. O. Mingle, N. D. Eckhoff, Kansas State Uni-
versity, Manhattan, Kansas

DYNAMICS OF A UNIVERSAL HYDROGEN FUEL SYSTEM

T. N. Veziroglu, University of Miami, Coral
Gables, Florida

ULTIMATE ENERGY, THE ULTIMATE FUEL AND THE HYDROGEN LINK - OUR ELECTRICAL ENERGY SYSTEM

C. M. Summers, University of Kansas, Lawrence,
Kansas

CLEAN ENERGY SYSTEM FOR JAPAN

T. Ohta, Yokohama National University
Yokohama, Japan

THE NUCLEAR ELECTRIC ECONOMY

P. N. Ross, Westinghouse Electric Corporation,
Pittsburgh, Pennsylvania

UTILIZATION OF HYDROGEN AS AN APPLIANCE FUEL

J. C. Sharer, J. B. Pangborn, Institute of Gas
Technology, Chicago, Illinois

THE HYDROGEN ECONOMY MIAMI ENERGY (THEME) CONFERENCE.

Presented by The School of Engineering &

Environmental Design, Univ. Miami, Coral
Gables, Florida.

Sponsored by The National Science Foundation,
Defense Advanced Research Projects Agency,
and The School of Continuing Studies, Univ.
of Miami.

Miami Beach, Florida, Mar.18-20,1974.

Hydrogen Storage and Transmission

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TRANSPORTATION AND STORAGE OF HYDROGEN

R. A. Reynolds, W. L. Slager, General Electric
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**ECONOMICS OF PIPELINE TRANSPORT FOR
HYDROGEN AND OXYGEN**

G. Beghi, Euratom, Ispra, Italy

**LOW THERMAL FLUX GLASS-FIBER TUBING FOR
CRYOGENIC SERVICE INCLUDING LH₂ STORAGE
SYSTEMS**

C. A. Hall, D. E. Spond, Martin Marietta Corp.,
Denver, Colorado

**ELECTRIC POWER AND FUEL TRANSMISSION BY
LIQUID HYDROGEN SUPERCONDUCTIVE PIPE-
LINE**

R. L. Whitelaw, Virginia Polytechnic Institute and
State University, Blacksburg, Virginia

**ARCHITECTURE OF AN AUTOMATIC SYSTEM FOR
SAFETY, METERING, AND CONTROL OF A
HYDROGEN TRANSMISSION PIPELINE**

J. G. Burgen, Teledyne Geotech, Garland, Texas

**OPTIMAL LOCATION OF HYDROGEN SUPPLY
CENTERS TO MINIMIZE DISTRIBUTION COSTS**

M. Avriel, V. Gurovich, Israel Institute of Tech-
nology, Haifa, Israel

HYDROGEN AS AN ENERGY CARRIER

R. G. Murray, Oklahoma State University, Still-
water, Oklahoma

**THE ROLE OF HYDROGEN IN ELECTRIC ENERGY
STORAGE**

F. J. Salzano, R. J. Isler, E. A. Cherniavsky, K. C.
Hoffman, Brookhaven National Laboratory, Long
Island, New York

**HYDROGEN ENERGY STORAGE FOR ELECTRICAL
UTILITY SYSTEMS**

C. Kippenhan, R. Corlett, University of Washing-
ton, Seattle, Washington

**AN ECONOMIC STUDY OF ELECTRICAL PEAK-
SHAVING ALTERNATIVES**

W. R. Parrish, U.S. Department of Commerce,
Boulder, Colorado

HYDROGEN AS ENERGY STORAGE ELEMENT

L. Zelby, The University of Oklahoma, Norman,
Oklahoma

THE HYDROGEN ECONOMY MIAMI ENERGY (THEME) CONFERENCE.

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Metal Hydride Storage

Session Chairman: F. Schulman,

Fred Schulman Associates,
Silver Spring, Maryland

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Coral Gables, Florida

**THE ACTIVATION OF A LANTHANUM-NICKEL-
FIVE HYDROGEN ABSORBENT**

H. H. van Mal, Philips Research Laboratories,
Geldrop, Netherlands

**AN ENGINEERING-SCALE ENERGY STORAGE
RESERVOIR OF IRON TITANIUM HYDRIDE**

G. Strickland, J. Reilly, R. Wiswall, Brookhaven
National Laboratory, Long Island, New York

**THE STORAGE OF HYDROGEN AS METAL
HYDRIDES**

D. L. Cummings, G. J. Powers, Massachusetts
Institute of Technology, Cambridge, Massachusetts

**MODELING STUDIES OF FIXED-BED METAL-
HYDRIDE STORAGE SYSTEMS**

W. S. Yu, E. Suuberg, C. H. Waide, Brookhaven
National Laboratory, Upton, New York

**THE SAFETY CHARACTERISTICS OF LaNi_5
HYDRIDES**

C. E. Lundin, University of Denver, Denver,
Colorado

**THE FORMATION AND PROPERTIES OF RARE-
EARTH AND TRANSITION METAL HYDRIDES**

L. C. Beavis, R. S. Blewer, J. W. Guthrie, E. J.
Nowak, W. G. Perkins, Sandia Laboratories,
Albuquerque, New Mexico

Hydrogen Storage in Vehicles

Session Chairman: L. W. Jones,
University of Michigan,
Ann Arbor, Michigan

Session Co-Chairman: J. Alexander,
University of Miami,
Coral Gables, Florida

**AMMONIA AS A HYDROGEN CARRIER AND ITS
APPLICATION IN A VEHICLE**

R. L. Graves, J. W. Hodgson, J. S. Tennant, The
University of Tennessee, Knoxville, Tennessee

**METAL HYDRIDES: EXPERIMENTAL METHODS
AND APPLICATION TO THE ELECTRIC VEHICLE**

P. Jonville, H. Stohr, R. Funk, M. Kornmann,
Battelle Centre de Recherche de Geneve, Geneva,
Switzerland

**THE APPLICATION OF METAL HYDRIDES TO
GROUND TRANSPORT**

C. H. Waide, K. C. Hoffman, J. J. Reilly, R. H.
Wiswall, Brookhaven National Laboratory, Long
Island, New York

**HYDROGEN STORAGE FOR AUTOMOBILES USING
METAL HYDRIDES AND CRYOGENICS**

R. E. Billings, Energy Research Corporation,
Provo, Utahs,

**STUDIES OF THERMAL STRATIFICATION IN LH_2
AUTOMOTIVE FUEL TANKS**

K. D. Williamson, Jr., J. R. Bartlit, F. J. Edeskuty,
W. F. Stewart, Los Alamos Scientific Laboratory,
University of California, Los Alamos, New
Mexico,

Prospects for hydrogen as an energy resource

J. K. Dawson

Atomic Energy Research Establishment, Harwell, UK

Storing energy in the form of hydrogen is an attractive possibility to provide fuel for transport and the reduction of iron ore. The main obstacle is the expense of the electricity needed to synthesise hydrogen.

S-449

HYDROGEN: A WAY OUT OF THE ENERGY CRISIS?

V.K. McElhery.

New York Times, Sunday, May 12, 1974, p.1,6.

This light, plentiful gas is an alternative to the all-electric economy in the year 2000.

(BNL-18634) ENGINEERING-SCALE ENERGY STORAGE RESERVOIR OF IRON TITANIUM HYDRIDE. Strickland, G.; Rally, J. J.; Wiswall, R. H. Jr. (Brookhaven National Lab., Upton, N. Y. (USA)). Feb 1974. 13p. (CONF-740306-12). Dep. NTIS \$3.00.

From hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

A hydrogen reservoir containing 14 lb of H₂ in the form of 893 lb of granular iron titanium hydride was constructed and tested. The reservoir will be used by Public Service Electric and Gas Co. of New Jersey to study the feasibility of storing off-peak electrical energy through the use of a water electrolyzer, a hydride reservoir, and a fuel cell stack. The internal functional components of the stainless steel vessel consist of a barrier in the form of porous metal tubes, and heat exchanger tubes. Details of construction, preparation of the hydride, and performance tests made at BNL are described. (auth)

(BNL-18721) ROLE OF HYDROGEN IN ELECTRIC ENERGY STORAGE. Salzano, F. J.; Cherniavsky, E. A.; Isler, R. J.; Hoffman, K. C. (Brookhaven National Lab., Upton, N. Y. (USA)). 1974. 16p. (CONF-740306-9). Dep. NTIS \$4.00.

From hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

Electricity must be provided by the utilities on demand that varies daily, weekly, and in a seasonal cycle. This results in the under-utilization of high capital cost generating facilities and the reliance on peaking devices such as gas turbines and pumped storage. Gas turbine generators, though presently economical, are highly inefficient and use high grade liquid or gaseous fossil fuels which may eventually be in short supply. The role of electric storage in utility systems is discussed. The technology of hydrogen production, storage, and reconversion to electricity as a technique for electric energy storage is discussed and shown by means of an optimization model to fit well into the United States energy system. (auth)

(LA-UR-74-528) LONG RANGE CONSIDERATIONS AND POSSIBILITIES OF HYDROGEN ECONOMY. Edeskuty, F. J. (Los Alamos Scientific Lab., N. Mex. (USA)). 1974. Contract W-7405-eng-36. 10p. (CONF-740119-1). Dep. NTIS \$4.00. From annual compressed gas association meeting; San Francisco, California, USA (28 Jan 1974).

Some available technology and uses of hydrogen to help relieve the energy problems are discussed. Electrical peak-shaving with hydrogen use means that any off-peak excess electrical power output would be used to electrolyze water. The resulting hydrogen and oxygen would be stored as liquids, as compressed gases or, in the case of hydrogen, as metal hydride. Electricity would be generated by the combustion of the stored hydrogen and oxygen to drive a high speed, high efficiency turbine. An alternate method would be the use of hydrogen and oxygen in a fuel cell. The use of hydrogen in aircraft and surface transportation in all its forms and the advantages and disadvantages are discussed. Hydrogen as a fuel in an internal combustion engine presents an efficiency factor sometimes quoted to be 50 percent. The safety parameters of hydrogen are compared with gasoline. Economy and public acceptance are discussed. The USA produced hydrogen in huge quantities that was utilized by the space program in the past decade. (MCW)

(LA-UR-74-340) CRYOGENICS SAFETY IN A HYDROGEN FUEL SOCIETY. Reider, R.; Edeskuty, F. J.; Williams, K. D. Jr. (Los Alamos Scientific Lab., N. Mex. (USA)). Incl. Contract W-7405-eng-36. 20p. (CONF-740509-1). Dep. NTIS \$3.00.

From fifth international cryogenic engineering conference; Kyoto, Japan (7 May 1974). An inevitable world-wide shortage of fossil fuel and concern for environmental pollution have aroused interest in hydrogen as a synthetic clean fuel. The storage, shipment, and use of hydrogen in a cryogenic fluid have already been demonstrated to be feasible and safe. To make liquid hydrogen a universally attractive fuel requires only an extension of existing technology. The fundamentals of cryogenic safety with specific attention to hydrogen are reviewed with respect to material properties, control of ignition sources, management of leaks, inerting and venting, analysis of spills, cold injury, air condensation and oxygen enrichment, pressure relief and thermal stresses. Problems of standards and regulations, safety training, development of operating procedures, and emergency plans must be addressed thoroughly before the common use of liquid hydrogen will receive public acceptance. The nature and consequences of hydrogen accidents are analyzed. (auth)

(BNL-18725) OPERATING MANUAL FOR THE PSE AND G HYDROGEN RESERVOIR CONTAINING IRON TITANIUM HYDRIDE. Strickland, G.; Reilly, J. J. (Brookhaven National Lab., Upton, N. Y. (USA)). Feb 1974. 40p. NTIS \$6.00.

The manual was written for use with the experimental energy-storage system. Information is provided on how the reservoir functions and how it can be safely operated. In combination with a water electrolyzer and a fuel-cell stack, the hydrogen reservoir provides a new way of storing energy. The reservoir is the storage unit in the system; it is used to store hydrogen from the electrolyzer and subsequently release it to the fuel-cell stack. A reservoir for hydrogen consists of a closed vessel filled with granular metal hydride and provided with a particle barrier, a gas connection, and a means of handling the necessary thermal load. In this case the hydrogen is stored as iron titanium hydride in a pressure vessel; porous metal tubing is used for the barrier, and an internal heat exchanger is provided to handle the thermal load. The hydride may be cycled many times provided gaseous impurities that degrade its performance are excluded from the system. Water at readily available temperatures (approximately 60 and 120°F) is suitable for use as the heat exchange medium. Tests have shown that design specifications may be exceeded. It will take up H_2 at a rate >1.5 lb/hr, deliver it at a rate >1.0 lb/hr, and its working capacity is significantly more than the 10 lb of H_2 originally specified. A compressor (500-psig rating) is required to pressurize H_2 leaving the electrolyzer in order to obtain a practical sorption rate. The temperature and flow rate of the water in the heat exchanger tubes also are an important factor with respect to sorption and desorption rates. (MCW)

METALLIC HYDROGEN STORAGE MATERIAL: HIGH COMPRESSION AND SAFE STORAGE OF THE GAS POSSIBLE. VDI (Ver. Deut. Ing.) Nachr.: 27: No. 44, 15 (Oct 1973). (In German).

One of the recent important achievements of the research work carried out in the Philips laboratories is the discovery of metallic hydrogen storage devices. The metallic storage material is described by the formula AB_2H_2 , with A standing for rare earth, B for either cobalt or nickel, and H for hydrogen. Hydrogen being added to $LaNi_5$, e.g., will result in the formation of the hydride $LaNi_5H_2$, with six H atoms being bound to one unit, whereas in $SrNi_5$, 2.5 H atoms are added to the compound. (CE)

1973

TK22896. I55 1973

(LA-UR-73-849) COMBINED NUCLEAR AND HYDROGEN ENERGY ECONOMY: A LONG-TERM SOLUTION TO THE WORLD'S ENERGY PROBLEM. Booth, L. A.; Balcomb, J. D.; Ederkuty, F. J. (Los Alamos Scientific Lab., N. Mex.). 1973. Contract W-7405-eng-36. 9p. (CONF-730811-8). Dep. NTIS \$3.00.

Future demand for the world's supply of carbon-based fuels eventually will exhaust this supply until their use becomes economically infeasible. Hydrogen, which is virtually inexhaustible in the form of water, could be substituted for natural gas and petroleum-based fuels for industrial and residential heating and for transportation. Nuclear energy, either fusion or fission, would be the primary energy source. Thermal energy from the nuclear heat source would be converted to electrical energy in a conventional heat-engine cycle. Hydrogen could be produced from water by a cyclic thermochemical process. Gaseous hydrogen for industrial and residential heat would be transported in a high-pressure pipeline system. Liquid hydrogen stored in metal hydrides could be used for transportation fuels. The basis of this future energy economy would be energy complexes of two types. Large plants, located off shore would produce hydrogen and electricity with desalted water as a byproduct. Smaller plants, located inland near urban centers, would produce primarily electricity and hydrogen. (auth)

1973

TITLE: Nuclear Heat and Hydrogen in Future Energy Utilization

AUTHOR: Booth, L. A.; Balcomb, J. D.
CORPORATE AUTHOR: Los Alamos Scientific Laboratory
ADDRESS: Los Alamos, NM 87544
PUBLICATION DESCRIPTION: Report No. LA-5456-MS, 28 p., 26 references

PUBLICATION DATE: 1973, November
SPONSOR: U.S. Atomic Energy Commission
ABSTRACT: Future demand for the world's supply of carbon-based fuels will eventually deplete this supply to the point at which their use becomes economically infeasible. Hydrogen, which is virtually inexhaustible in the form of water, could be substituted for natural gas and petroleum-based fuels for industrial and residential heating and for transportation. Nuclear energy, either fusion or fission, would be the primary energy source. Thermal energy from the nuclear heat source would be converted to electric energy in a conventional heat-engine cycle. Hydrogen could be produced from water by a cyclic thermochemical process. Gaseous hydrogen for industrial and residential heat would be transported in a high-pressure pipeline system. Liquid hydrogen or hydrogen stored in metal hydrides could be used for transportation fuels. Energy complexes of two types would form the basis of this future energy economy: Large plants, located offshore would produce hydrogen and electricity with desalted water as a byproduct; and smaller plants, located inland near urban centers, would produce primarily electricity and hydrogen. (auth)
AVAILABILITY: NTIS (\$3.00, printed copy: \$1.25, microfiche)

HD 9540.4. I5 1973

HYDROGEN AS THE UNIVERSAL FUEL. The new, non-fossil sources of energy are limited in that they are best available either in a continuous, level output (nuclear) or a periodic cycle (solar, wind, tides, etc.), and are best produced at fairly remote geographical sites. On the other hand, energy demands are localized in "load centers," and follow cycles which do not coincide with the production cycles. In the future, as these new energy sources are phased in, increased provisions for energy transmission and storage will be required. Hydrogen as an energy carrier presents a way to accommodate the differences between energy production limitations and energy demand patterns, both in location and time-cycles. The use of hydrogen permits relatively inexpensive, reliable, efficient underground energy transmission and the capability of bulk storage close to the load center. It presents a "bridge" between the fossil fuel sources and the non-fossil fuel sources to allow a transition of supply to be carried out in a planned and orderly manner. It presents the potential of an ultra-clean fuel to eliminate most of today's pollution problems. It presents a way to supply large sections of the energy consuming markets with domestic non-imported energy. 11 refs.

Gregory, D.P. Inst of Gas Technol. Chicago, Ill. /IEEE Intercon Tech Pap 1973, for Meet. New York, NY, Mar 26-30 1973, v 3, Pap 6/5, 6 p.

1973

TITLE: Cryogenic H₂ and National Energy Needs
AUTHOR: Word, J.
CORPORATE AUTHOR: U.S. Dept. of Commerce, National Bureau of Standards, Institute for Basic Standards, Cryogenics Division
ADDRESS: Boulder, CO 80302
PUBLICATION DESCRIPTION: Paper W-1, preprinted for the Cryogenic Engineering Conference, Atlanta, GA, August 8-10, 1973, 22 p., 81 references

PUBLICATION DATE: 1973
ABSTRACT: Our impending fossil fuel shortage is a clear challenge to the cryogenics industry and government to provide efficient and economical means of satisfying specific national fuel requirements. Large scale production of liquid hydrogen was stimulated by the U.S. space exploration program. Now, civilian demands for synthetic fuels beckon cryogenic hydrogen. National and world energy shortages are briefly summarized to demonstrate the relevance of synthetic fuels in satisfying future energy markets. A perspective of national energy needs, as they relate to cryogenic hydrogen fuel, is given. Hydrogen and alternate synthetic fuels are briefly reviewed and potential applications for cryogenic hydrogen are described. Technical research and development efforts, required to satisfy specific current and future national needs, are identified. The mechanism for implementation of synthetic fuels and the indistinct timetable for transition to these fuels are discussed. (Auth)

210

Hydrogen Transportable Storable Energy Medium

By DEREK P. GREGORY
Institute of Gas Technology

For future remote sources of power and sources with production cycles out of step with consumption, we will need hydrogen to get energy where needed when needed

HYDROGEN AND ENERGY.

C. Marchetti.

Chemical Economy & Engineering Review
published by the Chemical Economy Research
Institute, Japan, v.5, no.1(no.57)Jan.1973,
P.7-25.

LOOKING AT THE HYDROGEN ECONOMY.

Nature, v.243, May 25,1973, p.184,185.

THE HYDROGEN ECONOMY.

D.P. Gregory.

Scientific American, v.228, no.1, Jan.1973, p.13-21.

A case is made for an energy regime in which all energy sources would be used to produce hydrogen, which could then be distributed as a nonpolluting multipurpose fuel.

Two letters to the editor commenting on 'The Hydrogen Economy' by D.P. Gregory.(Sci. Amer., Jan.'73).

Scientific American, Apr.1973, Letters.

SECOND THOUGHTS ON THE HYDROGEN ECONOMY.
Science News, v.104, Sept.1,1973, p.135.

HYDROGEN: FUEL OF THE FUTURE?

A.P. Armagnac.

Popular Science, Jan.1973, p.64-67,128.

S-411

1973

HYDROGEN ECONOMY CONCEPT. Gregory, D. D. Pub. Utl. Forum, 91: No. 12, 57-59 (7 Jun 1973).

The Institute of Gas Technology has been conducting a study of the synthetic chemical fuel that can be produced from nuclear or solar energy and other readily available sources: hydrogen. Hydrogen can be produced from water by the addition of energy and can be oxidized back to water to give up this energy as heat or electric power directly. It is the perfect ecology fuel, a pollution-free recyclable fuel. Water can be converted to hydrogen and oxygen in three ways. Hydrogen can be stored in underground reservoirs or liquefied and stored in insulated tanks the same way that natural gas is stored today. Defined safety codes have been established for the use and storage of hydrogen. The economics for the development of hydrogen as a fuel is discussed. (JCN)

THE HYDROGEN ECONOMY.

C.A. McAuliffe.

Chemistry in Britain, v.9, no.12, Dec.1973, p.559-563.

Hydrogen production by electricity and by chemical means; aspects of its storage and distribution; and its use as a replacement for petroleum and natural gas are outlined in this article.

N74-18729# Los Alamos Scientific Lab., N.Mex. AND WHAT IF WE WERE TO SWITCH TO HYDROGEN? Yu. Medvedev and E. Muslin 1973 25 p Transl. into ENGLISH from Izobret. Izobret. i Ratsionalizatsiya. Irkutsk (Irkutsk), no. 318, 1973 p 40-44 (LA-TR-73-40) Avail: NTIS HC \$3.25

The use of ordinary water as a fuel source from which to derive hydrogen is proposed. The production of hydrogen by the reactions of the Mark-1 process and the process with iron-carbon catalysts is discussed. The pipelines and transport of hydrogen with its applications to fuel sources or everyday life are discussed. It is predicted that it will be possible to establish a powerful food chain depending neither on agriculture nor on oil reserves and based only on atomic energy. Scientists have been trying with the aid of hydrogen yeast to obtain food from carbon dioxide, mineral salts, and hydrogen obtained with electrolysis of water by current from solar batteries. The same hydrogen and oxygen could serve as an energy source for fuel cells. Author (NSA)

CT-140,562

1973
HYDROGEN AND SYNTHETIC FUELS FOR THE FUTURE.

John W. Michel, ORNL. (Presented to the ACS Symp. on Chemical Aspects of Hydrogen as a Fuel, Chicago, Ill., Aug.27-30,1973). 35p. Draft. Reproduced from best copy available; portions are illegible.

American Chemical Society

Atomic Energy Commission Conf-730807-3

Symposium on Chemical Aspects Aug.27-30,

of Hydrogen as a Fuel 1973

Hydrogen

Fuels - Synthesis

L-5-17-74

N74-18809# Brookhaven National Lab., Upton, N.Y.

HYDROGEN ECONOMY

V L Sailor 1973 23 p refs Presented at Seminar on Novel Power Sources for a Power Hungry World, Baltimore Sponsored by AEC

(BNL-18224) Avail: NTIS HC \$3.25

A brief discussion is given of the possibilities of synthetic-fuel energy conversion cycles. The advantages and disadvantages of using coal and oil shale products are indicated. Environmental and economical problems which remain during the product of synthetic fuels from coal and oil shale, and the advantages and disadvantages of hydrogen as a synthetic fuel are outlined. Technical problems involve storage and on-board tankage for vehicles and aircraft. Safety problems are also discussed. NSA

Ultimate energy, the ultimate fuel, and the hydrogen link in the electrical energy system. C.M. Simmons (Univ. Kansas, Lawrence, USA). 6th Annual Frontiers of Power Technology Conference, Stillwater, Okla., USA, 10-11 Oct. 1973. Stillwater, Okla.: Oklahoma State Univ. 1973, p.5/1-19

Considers some of the long-range potential solutions for the energy dilemma. An estimate is given for the ultimate energy and population that can be tolerated in the United States. The ultimate source of energy is discussed; hydrogen is suggested as the ultimate fuel and as an important link in the electrical energy system; and some thoughts are given regarding national and state energy objectives. (4 refs.)

1973

N74-11728* Houston Univ., Tex.
A HYDROGEN ENERGY CARRIER. VOLUME 2: SYSTEMS ANALYSIS
 Robert L. Savage, ed., Lee Blank, ed., Tom Cady, ed., Kenneth Cox, ed., Richard Murray, ed., and Richard Dee Williams, ed.
 Sep. 1973 158 p refs
 (Grant NGL-44-005-114)
 (NASA-CR-136007) Avail: NTIS HC \$10.00 CSCL 20M

A systems analysis of hydrogen as an energy carrier in the United States indicated that it is feasible to use hydrogen in all energy use areas, except some types of transportation. These use areas are industrial, residential and commercial, and electric power generation. Saturation concept and conservation concept forecasts of future total energy demands were made. Projected costs of producing hydrogen from coal or from nuclear heat combined with thermochemical decomposition of water are in the range \$1.00 to \$1.50 per million Btu of hydrogen produced. Other methods are estimated to be more costly. The use of hydrogen as a fuel will require the development of large-scale transmission and storage systems. A pipeline system similar to the existing natural gas pipeline system appears practical, if design factors are included to avoid hydrogen environment embrittlement of pipeline metals. Conclusions from the examination of the safety, legal, environmental, economic, political and societal aspects of hydrogen fuel are that a hydrogen energy carrier system would be compatible with American values and the existing energy system. For individual titles, see N74-11729 through N74-11735.

1973

N74-11727* Houston Univ., Tex. Systems Design Inst.
A HYDROGEN ENERGY CARRIER. VOLUME 1: SUMMARY

Robert L. Savage, ed., Lee Blank, ed., Tom Cady, ed., Kenneth Cox, ed., Richard Murray, ed., and Richard Dee Williams, ed.
 Sep. 1973 27 p
 (Grant NGT-44-005-114)
 (NASA-CR-135995) Avail: NTIS HC \$3.50 CSCL 20M

The production, technology, transportation, and implementation of hydrogen into the energy system are discussed along with the fossil fuel cycle, hydrogen fuel cycle, and the demands for energy. The cost of hydrogen production by coal gasification, electrolysis by nuclear energy, and solar energy are presented. The legal aspects of a hydrogen economy are also discussed.
 F.O.S.

1973

N74-11729* Houston Univ., Tex.
[SUMMARY OF SYSTEMS ANALYSIS OF HYDROGEN AS AN ENERGY CARRIER IN THE UNITED STATES]
In its A Hydrogen Energy Carrier, Vol. 2 Sep. 1973 p 1-3
 (For availability see N74-11728 02-33)
 CSCL 20M

Hydrogen is discussed in terms of meeting the energy demands of the current energy shortage in the U.S. Hydrogen is considered compatible with all fuel needs, except for on-board storage in automotive-type vehicles. Handling and safety factors are considered compatible to other high energy fuel. It is concluded that hydrogen is an environmentally desirable energy source, and is readily acceptable in the American energy system. F.O.S.

N74-11730* Houston Univ., Tex.
[CURRENT ENERGY SHORTAGE IN THE UNITED STATES]
In its A Hydrogen Energy Carrier, Vol. 2 Sep. 1973 p 5-12
 refs (For availability see N74-11728 02-33)
 CSCL 20M

An overview is presented of the study to use hydrogen as an energy source for meeting the current energy shortage. The fossil fuel cycle, and the hydrogen fuel cycle are discussed along with energy flow patterns.
 F.O.S.

N74-11732* Houston Univ., Tex.
TRANSMISSION AND STORAGE OF HYDROGEN
In its A Hydrogen Energy Carrier, Vol. 2 Sep. 1973 p 61-76
 refs (For availability see N74-11728 02-33)
 CSCL 20M

Transmission and storage techniques for hydrogen are evaluated. Gaseous hydrogen and natural gas systems are discussed along with liquid hydrogen systems, and solid hydride storage systems are described. It is concluded that hydrogen gas pipeline systems are feasible, but attention must be given to the embrittlement of pipeline metals.
 F.O.S.

1973

N74-15903 Rensselaer Polytechnic Inst., Troy, N.Y.
LONG RANGE TRENDS IN THE CHARACTER OF ELECTRIC
POWER SYSTEMS Ph.D. Thesis

Charles A. Falcone 1973 388 p
Avail: Univ. Microfilms Order No. 73-27204

Long range trends in the development of electric power systems in the United States are discussed, emphasizing the Midwestern region. The historical growth of energy consumption in the United States is examined, along with present status and near-term prospects. Demographic and societal trends are discussed, and energy and electric power consumption are projected to year 2100, based on a scenario of future American society. The fuel resources of the United States are examined, as well as current and developmental energy conversion technology. A forecast of fuel use is developed. A history of energy systems is epitomized, with particular attention to electric power systems. Alternative energy systems are compared, and an examination of a hydrogen-electric system is included.

Dissert Abstr

HYDROGEN: ITS FUTURE ROLE IN THE NATION'S
ENERGY ECONOMY Winsche, W. E.; Hoffman, K. C.; Salzano,
F. J. (Brookhaven National Lab., Upton, NY). Science; 180,
No. 4093, 1325-1332(29 Jun 1973).

The implementation is feasible for the role of hydrogen in the energy economy. It is shown that hydrogen could be a viable secondary source of energy derived from nuclear power; for the immediate future, hydrogen could be derived from coal. A hydrogen supply system could have greater flexibility and be competitive with a more conventional all-electric delivery system. Technological improvements could make hydrogen as an energy source an economic reality. The systems examined show how hydrogen could serve as a general-purpose fuel for residential and automotive applications, electrical applications of the household via fuel cells, turbines, or conventional total energy systems. The economics and safety factors of hydrogen utilization in energy systems are discussed. 22 references. (MCW)

TITLE: Hydrogen Fuel Economy: Wide-Ranging
Changes
CORPORATE AUTHOR: American Chemical Society
ADDRESS: 1155 Sixteenth St. NW, Washington, D.C.
20036

PUBLICATION DESCRIPTION: Chemical & Engineering
News, 50(28), 27-30

PUBLICATION DATE: 1972, July 10
ABSTRACT: This article deals with the general industrial implications of hydrogen's availability in large quantities at relatively low cost. Some of the areas of private and industrial life which would be affected by a conversion to a hydrogen fuel economy are transportation, process technology, appliances, and storage. (DCH)

N74-11733* Houston Univ., Tex.
USAGE OF HYDROGEN
In its A Hydrogen Energy Carrier, Vol. 2 Sep. 1973 p 77-116
refs (For availability see N74-11728 02-33)
CSCL 20M

Emphasis was placed on minimizing the use of fossil fuels, while meeting reasonable energy demands of our society. Due to the many and complex uses of energy, a careful study was made of the several different areas of the entire energy picture. The demand for energy involves a study of the forms of work and a forecast of the quantities required for each form. Also included is a plan to implement the conversion from present fuels to hydrogen, with a careful consideration being given to the impact of the conversion on society and the environment.

Author

N74-11734* Houston Univ., Tex.
SAFETY, LEGAL, ENVIRONMENTAL, ECONOMIC, POLITICAL AND SOCIAL ASPECTS OF HYDROGEN c34
In its A Hydrogen Energy Carrier, Vol. 2 Sep. 1973 p 117-146
refs (For availability see N74-11728 02-33)
CSCL 05C

The impact of the hydrogen energy system on society was studied. Areas discussed include: federal and state responsibilities for safety; appliance safety standards; industrial uses and safety; assessment of the danger in the widespread use of hydrogen; legal aspects of the energy system; and the environmental implications. F.O.S.

N74-11735* Houston Univ., Tex.
IMPLEMENTATION OF A HYDROGEN ENERGY CARRIER c15
SYSTEM
In its A Hydrogen Energy Carrier, Vol. 2 Sep. 1973 p 147-151
(For availability see N74-11728 02-33)
CSCL 13H

A program for the implementation, by stages, of a hydrogen energy system is proposed based on established methods of production, distribution, and use. The stages for the production of hydrogen progresses from coal gasification, through nuclear power to a hydrogen society. F.O.S.

HERE COMES THE HYDROGEN ERA.

J.H. Winchester.
Reader's Digest, Dec.1973, p.144-147.

CW-129,639 (1973)
THE ENERGY LABYRINTH. (1973). 15p.

Linde (Co.)
Union Carbide Corp.

Power sources
Energy
Hydrogen

WHEN HYDROGEN BECOMES THE WORLD'S CHIEF FUEL.
Business Week, Sept.23,1972, p.98,101,102.

The sea is full of it. It doesn't pollute,
and it returns to the sea after it is burned.

A HYDROGEN ECONOMY.

J. O'M. Bockris.
Science, v.176, June 23,1972, p.1323.

315

TITLE: Hydrogen as an Energy Vector: New Future Prospects for Applications of Nuclear Energy
AUTHOR: Beghi, G.
CORPORATE AUTHOR: Joint Nuclear Research Center
ADDRESS: Ispra, Italy
PUBLICATION DESCRIPTION: Report No. EUR 8038-B,
19 P.

PUBLICATION DATE: 1972
SPONSOR: Commission of the European Communities
ABSTRACT: In view of a wider penetration of nuclear energy in the energy field and therefore of a diversification of its applications, the usefulness of an intermediary energy vector is pointed out. From this point of view the interest of hydrogen is examined: present consumption, evolution in the future including potential utilizations. Among the hydrogen production processes, the method of dissociation of water with a closed cycle of chemical reactions and utilizing nuclear heat seems particularly promising. (Auth)

AVAILABILITY: NTIS

HYDROGEN ECONOMY: AN ULTIMATE ECONOMY. A PRACTICAL ANSWER TO THE PROBLEM OF ENERGY SUPPLY AND POLLUTION. Bockris, J. O'M. (Flinders Univ. of South Australia, Bedford Park); Appleby, A. J. Environ. This Mon.; 1: No. 1, 29-35(Jul 1972).

The present position on energy supply and pollution is surveyed, and it is concluded that present technology will make affluent life increasingly difficult to maintain from about 2000 AD. A totally new energy medium is required. The case is presented for using hydrogen as the medium of energy between remote energy producing sites and population centers—the hydrogen then being used to generate electricity on the site of use or, alternatively, being used directly as a fuel. The effects of a hydrogen economy on all aspects of life requirements are discussed in detail. A hydrogen economy would be entirely non-polluting and would make high energy-densities possible for all regions of the world, thus hastening the spread of uniform high living standards. (auth)

TP256.E43
1972

ELECTROCHEMISTRY OF CLEANER ENVIRONMENTS.
J. O'M Bockris. Penna. Univ. Ed.

Chapter on: 'The Hydrogen Economy'

TK Intersociety Energy Conversion Engineering
2896 Conference, 7th, San Diego, Calif., 1972.
I 55 Proceedings. Washington, D. C., American
1972 Chemical Society, 1972.
1533 p. illus. 28 cm.

Experience in Handling, Transport and Storage of Liquid Hydrogen—The
J. R. Bartlit, F. J. Edeskuty, K. D. Williamson, Jr.

Recyclable Fuel 1312

WHEN THERE'S NO MORE OIL AND GAS.

F. Bacon and T. Fry.

New Scientist, Aug. 10, 1972, p. 285-287.

The only real substitute for oil products and natural gas is likely to be hydrogen, produced from water using electricity generated by nuclear reactors.

S-434

HYDROGEN MAY EMERGE AS THE MASTER FUEL TO POWER
A CLEAN-AIR FUTURE.

W. Clark

Smithsonian, v. 3, no. 5, Aug. 1972, p. 13-19.

A new concept in energy transmission

Gregory, D. P., Publ. Util. Fortn., 89, 21-29, (3 Feb. 1973). Considers costs and methods of energy transmission via hydrogen electrolysis and combustion which offers an attractive alternative to conventional power transmission. GA

Hydrogen: candidate for universal fuel

Gregory, D. P., Chem. Engng News, 50, (18), 34-38, (17 Apr. 1972). Briefly points advantages, considers uses and methods of production. DTI

Hydrogen: likely fuel of the future

Anon., Chem. Engng News, 50, (26), 14-17, (June 1972). This article considers arguments and actions relating to hydrogen's use as an energy carrier in a hydrogen fuel economy of the future. It is pointed out that hydrogen ever to achieve large-scale use, there must be large-scale production. SE

HYDROGEN: TOMORROW'S FUEL?

N. P. Chohey.

Chemical Engineering, Dec. 25, 1972, p. 24-26.

CH-129,791

1972

A HYDROGEN-ENERGY SYSTEM. D. P. Gregory. (Prepared for American Gas Assoc.). Aug. 1972.

Institute of Gas Tech.

(Chicago, Ill.)

American Gas Association

This is a review of economic, technological and ecological aspects of production, transportation and utilization of hydrogen as one of the most important sources of energy in the future. The following highlights are detailed—energy supply; nuclear electric power; nuclear chemical power; hydrogen fuel; and hydrogen production, transmission and production cost. The benefits of the system described are indicated.

TK2896. I55 1972

PRODUCTION AND DISTRIBUTION OF HYDROGEN AS A UNIVERSAL FUEL. Gregory, D. P.; Wurm, J. (Inst. of Gas Tech., Chicago). pp 1329-1334 of 7th Intersociety Energy Conversion Engineering Conference. Washington, DC: American Chemical Society (1972).

From 7th Intersociety energy conversion engineering conference; San Diego, California, USA (25 Sep 1972). See CONF-720925-

Electric power is an expensive energy form to transmit and deliver and cannot readily be stored. A synthetic chemical fuel could be storable and cheaper to transmit. Hydrogen made from nuclear power appears as the cleanest and simplest candidate for an energy-distribution medium. Its combustion products are compatible with the atmosphere. Hydrogen could, in principle, be distributed as universally as natural gas is today, using most of the same technology. But its use would present some new technological problems. It could do all of the jobs done by natural gas, and more. Its universal availability would give rise to new technological opportunities. Transition to a "hydrogen economy" would have to be a well-planned, nationwide operation. Since hydrogen can easily be made today from conventional fossil fuels, it could bridge the gap between the fossil age and the nuclear age by a well-thought-out conversion program. (MCW)

TK2896. I55 1972

ECO-ENERGY. Hausz, W.; Leeth, G.; Meyer, C. (General Electric Co., Santa Barbara, CA). pp 1316-1322 of 7th Intersociety Energy Conversion Engineering Conference. Washington, American Chemical Society (1972).

From 7th Intersociety energy conversion engineering conference; San Diego, California, USA (25 Sep 1972). See CONF-720925-

To study our future national electrical energy needs and means of supplying them, a system analysis must give balanced attention to ecological, economic, and societal factors. A parametric analysis of post-1990 systems and transitional modes identified a promising candidate system: the use of efficient gas turbines or fuel cells, at distribution level, which burn pipeline-delivered hydrogen generated at large, remotely located energy centers. (auth)

TK2896. I55 1972

SAFE DISTRIBUTION AND HANDLING OF HYDROGEN FOR COMMERCIAL APPLICATION. Martin, F. A. (Union Carbide Corp., Tonawanda, NY). pp 1335-1341 of 7th Intersociety Energy Conversion Engineering Conference. Washington, DC: American Chemical Society (1972).

From 7th Intersociety energy conversion engineering conference; San Diego, California, USA (25 Sep 1972). See CONF-720925-

The United States Government has used liquid hydrogen for approximately 20 years in their atomic energy research and rocket engine programs. During this period, a commercial business has been established to provide chemical, steel, and the electronics industries with large quantities of this gas. Growing needs for a cleaner, more-powerful, and better-performing fuel will turn toward the use of hydrogen. The equipment, regulations, and procedures that have permitted increased safe commercial usage of hydrogen are discussed. Consideration is also given to some of the problems that still must be overcome to permit the use of hydrogen as a common fuel. (auth)

1972

Hausz, W.; Leeth, G.; Lueck, D., and Meyer, C., "Hydrogen Systems for Electric Energy", 72TMP-15, General Electric Company, 1972.

Reynolds, R. A. and Slager, W. L., "Transportation and Storage of Hydrogen for Eco-Energy", GE72TMP-54, General Electric Company, December, 1972.

IS HYDROGEN THE FUEL OF THE FUTURE?
R.J. Trotter.

Science News, v.102, July 15, 1972, p.46,47.

Some scientists are predicting that hydrogen will be an effective replacement for fossil fuels before the end of the century.

TK2896. I55 1972

HYDROGEN-ELECTRIC UTILITY SYSTEM WITH PARTICULAR REFERENCE TO FUSION AS THE ENERGY

SOURCE. Tanner, E. C. (Princeton Univ., NJ); Huse, R. A. pp 1323-1328 of 7th Intersociety Energy Conversion Engineering Conference. Washington, DC: American Chemical Society (1972).

From 7th Intersociety energy conversion engineering conference; San Diego, California, USA (25 Sep 1972). See CONF-720925-

The use of hydrogen for large-scale energy storage, transmission, and distribution is discussed. A numerical example is given for one specific configuration—a fusion reactor linked to an electrolyzer plant. The advantages lie in the abundance of hydrogen, the low cost and high reliability of transmitting energy by pipeline, and the elimination of many constraints on plant siting. Problems arise from inefficiencies in electrolysis and in the reconversion of hydrogen to electricity. These inefficiencies result in more waste heat and drive up costs to the customers. Technological improvements can be expected that will lead to more efficient performances. (auth)

317

1972

1972

TP490.A3 V.18

TITLE: Clean Energy Via Cryogenic Technology
AUTHOR: Williams, L.O.
CORPORATE AUTHOR: Martin Marietta Aerospace
ADDRESS: Denver, CO
PUBLICATION DESCRIPTION: Part of Advances in Cryogenic Engineering, Volume 16, Proceedings of the 1972 Cryogenic Engineering Conference, National Bureau of Standards, Boulder, CO, August 9-11, 1972, Plenum Press, p. 502-520, 27 references

PUBLICATION DATE: 1972

ABSTRACT: The author proposes an energy production-distribution system based on hydrogen. Large nuclear reactors, either fission or fusion, would be floated or sunk in the ocean. These plants would be used to generate electricity, distill sea water, and manufacture hydrogen through electrolysis. The hydrogen would be cooled and dried, and then could be transported over very large distances by pipelines with very low losses. Hydrogen combustion causes no pollution, and can be used as an automotive fuel with very little modification to the present engines. The safety of hydrogen is discussed, along with the use of the oxygen produced in the electrolysis of water. The problem of disposal of nuclear wastes from the power plants, the implementation of the hydrogen energy system, and the economics of the plan. (MPC)

AVAILABILITY: Publisher (\$30.00 for entire proceedings)

THE CLEANING OF AMERICA. L.O. Williams, Martin Marietta Corp.
Astronautics & Aeronautics, Feb.1972, p.42-51.

Automobiles, airplanes, powerplants, and steel mills will turn into models of ecological virtue, and we can rejuvenate rivers, and...more, when we switch to a nuclear-hydrogen energy system.

HYDROGEN MAY BE THE FUTURE'S BASIC FUEL.
Tech. Forecasts, May 1972, p.7-9.

1972

TITLE: The Coaling Hydrogen Economy
AUTHOR: Lessing, L.
PUBLICATION DESCRIPTION: Fortune, 86(5), 138-146
PUBLICATION DATE: 1972, November
ABSTRACT: An economy based on hydrogen, rather than hydrocarbons, is discussed. Hydrogen could be obtained by electrolysis at floating offshore nuclear power plants. Hydrogen would flow onshore through underground pipelines and could be used to heat homes, generate electricity, or power vehicles. In spite of the "Hindenburg syndrome", hydrogen is a relatively safe fuel to transport and use. Space research has provided major advances in hydrogen technology, no major breakthroughs are needed to move to a hydrogen economy. The economics of electrolyzing water are discussed, along with the use of liquid hydrogen, particularly in automobiles. Hydrogen can be used in many industrial processes, including the direct reduction of iron ore, which could result in "clean" steel plants. A balanced national energy policy is needed to encourage the development of hydrogen as an energy source along with other sources such as solar, geothermal, and thermonuclear energy. With some developmental effort, hydrogen could be in use as a fuel by the mid 1980's. (MPC)

Powdered hydrogen could be clean fuel of the future (LaNi & SmCo) [Phillips Laboratories, Eindhoven] P. Hill. Engineer, 235 (13 Jul 72) p.53. il.

TK2896. I55 1971

W. E. Winsche, T. V. Sheehan and K. C. Hoffman, "Hydrogen--A Clean Fuel for Urban Areas," Intersociety Energy Conversion Engineering Conference Proceedings, p. 38, August 1971.

Deen, J. L., and Schoepel, R. J., Hydrogen and the Electric Economy, Proceedings, Frontiers of Power Technology Conference, Oklahoma State University, Stillwater, Okla., September 30-October 1, 1971, p 10-1.

313

A71-44365

Liquid hydrogen as a fuel for the future.
Lawrence W. Jones (Michigan, University, Ann Arbor, Mich.).
Science, vol. 174, Oct. 22, 1971, p. 367-370. 13 refs.

The use of liquid hydrogen as a long-term replacement for hydrocarbon fuel for land and air transportation seems technically feasible. It is an ideal fuel from the standpoint of a completely cyclic system, serving as a 'working substance' in a closed chemical and thermodynamic cycle. The energy-per-unit-weight advantage over gasoline or any other hydrocarbon fuel makes liquid hydrogen particularly advantageous for aircraft and long-range land transport. As a pollution-free fuel, it must be seriously considered as the logical replacement for hydrocarbons in the 21st century. G. R.

Sindt, C. "A Summary of the Characterization Study of Slush Hydrogen", *Cryogenics*, v. 10, n. 4, p. 372, October, 1970.

A COMPARISON OF THE COSTS OF PROVIDING HEAT, LIGHT,
AND POWER BY HYDROGEN AND OIL.

A.H. Stodhart.

Electrical Research Assoc. Tech Rept. C/1111.
Sept. 1953.

665.81

Sc8

Scott, Russel Burton, 1902-^{ed.}

Technology and uses of liquid hydrogen, edited by R. B. Scott, W. H. Denton, and C. M. Nicholls. Oxford, New York, Pergamon Press; distributed in the Western Hemisphere by Macmillan, New York, 1964.

415 p. illus. (part col.) 24 cm.

Includes bibliographies.

L. Lessing, "Fortune", "The Master Fuel
of a New Age". May, 1961.

THERMOCHEMICAL WATER DECOMPOSITION PROCESSES.

R.E. Chao

Ind. Eng. Chem., Prod. Res. Develop., v.13,
no.2, 1974, p.94-101.

A survey of various thermochemical hydrogen production schemes that have been reported in the literature up to 1973 is presented. These processes are grouped into four basic families: halide processes, processes based on the Reverse Deacon reaction, iron and carbon oxide processes, and metal and alkali metal processes. A brief discussion is included on the thermodynamics of multistep chemical cycles that would produce hydrogen from water without net consumption of other chemicals. Process conditions for several such processes are presented and compared with water electrolysis. Hydrogen production via thermochemical water splitting processes is reviewed in the context of a hydrogen based economy.

FUTURE AVAILABILITY OF LIQUID HYDROGEN.

W.J.D. Escher.

Astronautics & Aeronautics, v.12, no.5, May 1974,
p.55-59.

In the long run water-splitting processes, not based on fossil fuels, can supply large quantities of hydrogen at a commercially viable price, particularly if the production system produces not only hydrogen but also byproducts.

NUCLEAR WATER SPLITTING AND THE HYDROGEN ECONOMY.

J.L. Russell, Jr.

Power Engineering, v.78, no.4, Apr.1974,
p.48-51.

Non-electric energy demand by itself in the year 2000 is projected to exceed today's combined electric and non-electric demand. Hydrogen, produced by thermal decomposition of water, presents a partial solution. Either coal or a nuclear reactor can be used to produce heat to drive the reactions. Projected cost figures per cubic foot for hydrogen are charted for both conditions.

PLANT COSTS FOR PROCESSING HYDROGEN.

W.L. Nelson.

Oil & Gas Jour, v.72, no.10, Mar.11,1974, p.111,112.

THERMOCHEMICAL HYDROGEN GENERATION.

R.H. Wentorf, Jr. and R.E. Hanneman.

Science, v.185, July 26,1974, p.311-19.

Discussion of closed-cycle thermochemical processes--criteria for process selection and economic comparisons.

THE HYDROGEN ECONOMY MIAMI ENERGY (THEME) CONFERENCE.

Presented by The School of Engineering & Environmental Design, Univ. Miami, Coral Gables, Florida.

Sponsored by The National Science Foundation, Defense Advanced Research Projects Agency, and The School of Continuing Studies, Univ. of Miami.

Miami Beach, Florida, Mar. 18-20, 1974.

Hydrogen Production Using Solar Energy I

Session Chairman: C. Marchetti,
Euratom, Ispra, Italy

Session Co-Chairman: H. A. B. Wiseman,
University of Miami,
Coral Gables, Florida

THERMOCHEMICAL WATER CRACKING USING SOLAR HEAT

C. J. Sweet, The Johns Hopkins University, Silver Spring, Maryland

PERFORMANCE AND OPTIMIZATION STUDY OF A SOLAR POWERED HYDROGEN PLANT

D. V. Merrifield, Sperry Rand Corporation, Huntsville, Alabama

SOLAR ENERGY AND HYDROGEN PRODUCTION - AN EXAMINATION OF TWO POSSIBLE SYSTEMS

D. O. Lee, W. H. McCulloch, Sandia Laboratories, Albuquerque, New Mexico

UTILIZATION OF SOLAR ENERGY FOR HYDROGEN PRODUCTION BY CELL FREE SYSTEM OF PHOTOSYNTHETIC ORGANISMS

A. Mitsui, University of Miami, Coral Gables, Florida

ONLY SOLAR ENERGY PROCESSES WILL BRING US TO THE HYDROGEN ECONOMY

W. Heronemus, University of Massachusetts, Amherst, Massachusetts

SEA SOLAR POWER AS A HYDROGEN GENERATOR

J. H. Anderson, Sea Solar Power, Inc., York Pennsylvania

OCEAN BASED SOLAR-TO-HYDROGEN ENERGY CONVERSION MACRO SYSTEM

W. J. D. Escher, Escher Technology Associates, St. Johns, Michigan; J. A. Hanson, Oceanic Institute, Waimanalo, Hawaii

SOLAR-HYDROGEN GENERATION WITH MULTIPLE FREE PISTON STIRLING ENGINES

J. Rauch, W. Beale, S. Lewis, Ohio University, Athens, Ohio

PHOTOLYSIS OF WATER AS A SOLAR ENERGY CONVERSION PROCESS: AN ASSESSMENT

S. Paleocrassas, Tri-State College, Angola, Indiana

Electrolytic Hydrogen Production

Session Chairman: J. W. Michel,

Oak Ridge National Laboratory,
Oak Ridge, Tennessee

Session Co-Chairman: C. Criss, University of Miami,
Coral Gables, Florida

NEW APPROACHES TOWARDS LOW COST HYDROGEN FROM ELECTROLYSIS

J. O. M. Bockris, The Flinders University of South Australia, Adelaide, Australia

ELECTROLYTIC HYDROGEN GENERATORS

J. B. Laskin, Teledyne Isotopes, Timonium, Maryland

ELECTROLYSIS OF SEA WATER

L. O. Williams, Martin Marietta Aerospace, Denver, Colorado

HYDROGEN GENERATION THROUGH STATIC FEED WATER ELECTROLYSIS

F. C. Jensen, F. H. Schubert, Life Systems, Inc., Cleveland, Ohio

THE PRODUCTION OF HYDROGEN BY ELECTRO-CHEMICAL MEANS

H. L. Craig, Jr., University of Miami, Coral Gables, Florida

Thermochemical Hydrogen Production

Session Chairman:

R. Zahradnik
National Science Foundation,
Washington, D.C.

Session Co-Chairman:

H. L. Craig, University of Miami,
Coral Gables, Florida

EVALUATION OF MULTI-STEP THERMOCHEMICAL PROCESSES FOR THE PRODUCTION OF HYDROGEN FROM WATER

J. E. Funk, W. L. Conger, R. H. Carty, University
of Kentucky, Lexington, Kentucky

CONSIDERATIONS ON IRON-CHLORINE-OXYGEN REACTIONS IN RELATION TO THERMOCHEMICAL WATER SPLITTING

G. DeBenni, C. Hardy, Euratom, Ispra, Italy

THERMOCHEMICAL HYDROGEN PRODUCTION RESEARCH

R. G. Hickman, O. H. Krikorian, W. J. Ramsey,
Lawrence Livermore Laboratory, University of
California, Livermore, California

ANALYSIS OF THERMOCHEMICAL WATER-SPLITTING CYCLES

J. B. Pangborn, J. C. Sharer, Institute of Gas
Technology, Chicago, Illinois

A SEARCH FOR THERMOCHEMICAL WATER-SPLITTING CYCLES

J. L. Russell, J. T. Porter, Gulf General Atomic
Company, San Diego, California

Hydrogen Production Alternatives

Session Chairman:

J. E. Funk,
University of Kentucky,
Lexington, Kentucky

Session Co-Chairman:

L. Poteat, University of Miami,
Coral Gables, Florida

AN ANALYSIS OF HYDROGEN PRODUCTION VIA CLOSED-CYCLE SCHEMES

R. E. Chao, University of Puerto Rico, Mayaguez,
Puerto Rico, K. E. Cox, University of New
Mexico, Las Cruces, New Mexico

EVALUATION OF CHEMICAL METHODS TO PRODUCE HYDROGEN AS A FUEL

T. G. Somer, Middle East Technical University,
Ankara, Turkey

DESIGN AND ANALYSIS OF PROPOSED CHEMICAL PROCESSES FOR HYDROGEN MANUFACTURE

C. Miaw, B. Williams, The University of Michigan,
Ann Arbor, Michigan

HYDROGEN OPPORTUNITIES IN SAUDI ARABIA

H. Abdel-Aal, E. Peattie, College of Petroleum and
Minerals, Dhahran, Saudi Arabia

Hydrogen Production Using Nuclear Energy

Session Chairman:

J. W. Landis,
Gulf General Atomic Company,
San Diego, California

Session Co-Chairman:

H. Plass, University of Miami,
Coral Gables, Florida

NUCLEAR WATER SPLITTING, PROCESS HEAT AND HTR

H. Barnert, R. Schulten, Nuclear Research Center,
Julich, West Germany

HIGH TEMPERATURE NUCLEAR REACTORS AS AN ENERGY SOURCE FOR HYDROGEN PRODUCTION

J. Balcomb, L. Booth, Los Alamos Scientific
Laboratory, Los Alamos, New Mexico

HYDROGEN PRODUCTION WITH A HIGH TEMPERATURE GAS-COOLED REACTOR (HTGR)

R. N. Quade, A. T. McMain, Jr., Gulf General
Atomic Company, San Diego, California

HYDROGEN PRODUCTION FROM DECOMPOSITION OF WATER BY MEANS OF NUCLEAR REACTOR HEAT

S. Dorner, C. Keller, Gesellschaft fur Kern-
forschung mbH., Karlsruhe, West Germany

THE TECHNOLOGY AND ECONOMICS OF HYDROGEN PRODUCTION FROM FUSION REACTORS

J. R. Powell, F. J. Salzano, W. Seviran, Brookhaven
National Laboratory, Long Island, New York

AQUEOUS HOMOGENEOUS REACTOR FOR HYDROGEN PRODUCTION

W. Kerr, D. Majumdar, The University of
Michigan, Ann Arbor, Michigan

(KFK-1915) HYDROGEN PRODUCTION FROM WATER BY REACTOR HEAT. Dörner, S.; Schmitt, W. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Neutronenphysik und Reaktortechnik). Feb 1974. 48p. (In German). Dep. NTIS (U. S. Sales Only) \$5.50.

The already proposed or known procedures of obtaining hydrogen by means of reactor heat are discussed. The critical review shows that so far an adequate procedure cannot be proposed; therefore, we attempted to indicate novel processing means using an extended process systematics. New working hypotheses can be established on the basis of this process systematics. (auth)

(ORNL-TM-4370, pp 281-287) HYDROGEN PRODUCTION. Feb 1974.
In Chemical Development Section B semiannual progress report, March 1, 1973-August 31, 1973. Part I.
Research on enzymatic and thermal hydrogen production is reported. (Lk)

(UCRL-75095) THERMOCHEMICAL HYDROGEN PRODUCTION RESEARCH AT LAWRENCE LIVERMORE LABORATORY. Hickman, R. G.; Krikorian, O. H.; Ramsey, W. J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jan 1974. 13p. (CONF-740306-7). Dep. NTIS \$4.00.

From hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

Three novel closed-cycle processes for the thermochemical production of hydrogen from water are under study at the Lawrence Livermore Laboratory. The first cycle is based upon selenium and its compounds, the second on mercury, and the third on methane and methanol. None of these cycles involves halogens, and reaction temperatures are limited to 700°C. Although still in the conceptual stages, some preliminary experiments have been conducted on the first two processes, with the main effort on the first process. (auth)

(BNL-18718) TECHNOLOGY AND ECONOMICS OF HYDROGEN PRODUCTION FROM FUSION REACTORS. Powell, J.; Salzano, F. F.; Seivian, W. A. (Brookhaven National Lab., Upton, N. Y. (USA)). 1974. 17p. (CONF-740306-8). Dep. NTIS \$4.00.

From hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

The technology, economics, and environmental effects of producing synthetic fuels (H₂ gas, H₂ liquid, and methanol) based on fusion (CTR) reactors are assessed. Four U. S. energy systems (2020 AD) with different degrees of CTR implementation are compared: in System A, no CTR input is assumed; in System B, CTR's replace 50% of nuclear fission electric; in System C, CTR's supply all electrical demand, produce synthetic fuels to replace all oil and gas imports, and eliminate strip mining; and in System D, CTR's supply all electrical demand and virtually all fuel demand. CTR reactor costs are analyzed in detail for a range of component parameters, reactor outputs, and first wall loadings for DT and catalyzed DD fuel cycles. (auth)

TITLE: Hydrogen Production by Photosynthesis and Hydrogenase Activity, Progress Report for Period July 1, 1972 to March 1, 1973
AUTHOR: Krasnitz, L.O.
CORPORATE AUTHOR: Case Western Reserve University, Dept. of Microbiology
ADDRESS: Cleveland, OH 44106
PUBLICATION DESCRIPTION: Report No. MSP/RA/N-73-015, 46 p.
PUBLICATION DATE: 1973, April 14

SPONSOR: National Science Foundation, RANN Program
ABSTRACT: This report presents evidence for the biophotolysis of water to hydrogen and oxygen by systems: (1) Spinach chloroplasts forming reduced triphosphopyridine (TPP) nucleotide photosynthetically and hydrogen formation from it as catalyzed by a bacterial hydrogenase; (2) Same as above but with methyl viologen as electron acceptor; and (3) The blue-green algae, ANACYSTIS NIDULANS, forming TPP photosynthetically and hydrogen formation from it by bacterial hydrogenase. It also reports the synthesis of viologen dyes which may act as electron acceptors in the photosynthetic system. (MSP)
AVAILABILITY: NTIS, PB-227-746 (\$5.50 paper copy/\$1.45 microfiche)

TITLE: Hydrogen Production by Photosynthesis and Hydrogenase Activity--An Energy Source, Summary of Progress Obtained During the Period March 1, 1973 to July 1, 1973

AUTHOR: Krasnitz, L.O.
CORPORATE AUTHOR: Case Western Reserve University, Dept. of Microbiology
ADDRESS: Cleveland, OH 44106
PUBLICATION DESCRIPTION: Report No. MSP/RA/N-73-017, 6 p.
PUBLICATION DATE: 1973, August 24

SPONSOR: National Science Foundation, RANN Program
ABSTRACT: This report first reviews the research performed during the previous reporting period on using solar energy captured by the photosynthetic action of green plants and algae coupled with the action of the enzyme hydrogenase to bring about the biophotolysis of water to hydrogen and oxygen. During this reporting period research was performed on the use of ANACYSTIS NIDULANS for hydrogen formation when used in conjunction with bacterial preparation from CLOSTRIDIUM KLUYVERI. (MSP)
AVAILABILITY: NTIS, PB 228 760 (\$8.00 paper copy/\$1.45 microfiche)

TITLE: Biophotolysis of Water to Hydrogen and Oxygen

AUTHOR: Krasnitz, L.O.
CORPORATE AUTHOR: Case Western Reserve University, Dept. of Microbiology
ADDRESS: Cleveland, OH 44106

PUBLICATION DESCRIPTION: Abstract of paper presented at Annual Meeting of American Society for Photobiology, 2 p.
PUBLICATION DATE: 1973, June 12

SPONSOR: National Science Foundation, RANN Program
ABSTRACT: The research to be reported is concerned with the biophotolysis of water to hydrogen and oxygen by coupling the activity of the bacterial enzyme, hydrogenase, with the reducing power created by photosystems I and II of the photosynthetic apparatus. It is generally accepted that the two systems operating in tandem are capable of placing an electron from the oxygen-water couple at +0.8 volts to a potential as low as -0.7 volts, pH 7.0. Since at this pH the hydrogen electrode has a potential of -0.42 volts it is thermodynamically feasible to employ the electrons obtained by the two photosynthetic systems to obtain hydrogen. (auth)

(LA-5456-MS) NUCLEAR HEAT AND HYDROGEN
IN FUTURE ENERGY UTILIZATION. Booth, L. A.; B. Lomb.
J. D. (Los Alamos Scientific Lab., N. Mex. (USA)). Nov 1973.
Contract W-7405-eng-38. 28p. Dep. NTIS \$4.00.

Future demand for the world's supply of carbon-based fuels will eventually deplete this supply to the point at which their use becomes economically infeasible. Hydrogen, which is virtually inexhaustible in the form of water, could be substituted for natural gas and petroleum-based fuels for industrial and residential heating and for transportation. Nuclear energy, either fusion or fission, would be the primary energy source. Thermal energy from the nuclear heat source would be converted to electric energy in a conventional heat-engine cycle. Hydrogen could be produced from water by a cyclic thermochemical process.

Gaseous hydrogen for industrial and residential heat would be transported in a high-pressure pipeline system. Liquid hydrogen or hydrogen stored in metal hydrides could be used for transportation fuels. Energy complexes of two types would form the basis of this future energy economy: large plants, located offshore would produce hydrogen and electricity with desalted water as a byproduct; and smaller plants, located inland near urban centers, would produce primarily electricity and hydrogen. (46 references) (auth)

(COO-3028-6) PADRE SOL AND CHEMICAL FUEL
PRODUCTION. Axtmann, R. C. (Princeton Univ., N. J.). Ind. Contract AT(11-1)-3028. 13p. (CONF-730846-1). Dep. NTIS \$3.00.

From science and man in the Americas conference; Mexico City, Mexico (20 Jun 1973).

The problem of energy storage during the periods of night or cloud cover is considered, and it is suggested to combine the electrical power plant with a chemical fuel plant: a portion of the solar energy would be used to electrolyze water to produce hydrogen fuel. Another use of solar energy is in the production of fuels from organic wastes and plants; a continuous unit for converting organic material to methane gas in an anaerobic fermentation step is illustrated. Two other possibilities are also considered briefly: biophotolysis of water to produce hydrogen and enzymatic reduction of organic materials to clean fuels. Finally, a brief comparison is made between the costs of present-day fuels and solar-derived fuels. 4 figures. (DLC)

TK2896. I55 1973

HYDROGEN FUEL: PRODUCTION BY BIOCONVERSION. Investigation of the possibilities of biological production of hydrogen, a process carried out by a number of photosynthetic algae and bacteria. Several green algae have been tested for their ability to produce hydrogen gas in the light when grown and/or maintained in domestic sewage. Sewage is easily kept low in oxygen, a condition that is necessary for hydrogen production by the green algae. The light-requiring reactions leading to hydrogen production by green algae are described. 15 refs.

Blankenship, Dale T. Univ of Cincinnati, Ohio; Winget, G. Douglas. *Interac Energy Convers Eng Conf. 8th. Proc. Pap. Univ of Pa. Philadelphia. Aug 13-17 1973* p 580-582. Publ by AIAA, New York, 1973.

TITLE: An Analysis of Hydrogen Production via Closed-Cycle Schemes

AUTHOR: Chao, B.R.; Coz, R.E.
CORPORATE AUTHOR: (Chao) University of Puerto Rico; (Coz) University of New Mexico
ADDRESS: University of Puerto Rico, Mayaguez, P.R.; University of New Mexico, Albuquerque, N.M.

PUBLICATION DESCRIPTION: Paper presented at The Hydrogen Economy Nial Energy (THENE) Conference, March 18-20, 1974, Miami Beach, Florida

PUBLICATION DATE: 1974, March 18
ABSTRACT: A thermodynamic analysis and state-of-the-art review of three basic schemes for production of hydrogen from water: electrolysis, thermal water splitting, and multi-step thermochemical closed cycles is presented. Criteria for work-saving thermochemical closed-cycle processes are established and several schemes are reviewed in light of such criteria. An economic analysis is also presented in the context of energy costs. (auth)

AVAILABILITY: Author or the School of Engineering and Environmental Design, University of Miami, Coral Gables, Fla.

ECONOMICS OF PRODUCING HYDROGEN FROM GASEOUS FEEDSTOCK. Existing methods of producing hydrogen are analyzed from economic point of view. The most economical process of hydrogen production from gaseous feed at a refinery has been shown to be the thermal decomposition on fixed packing. However, this process cannot be recommended at present for wide use, since it has not been sufficiently developed on the industrial scale. Of the methods developed industrially, the most effective is conversion with steam, which is more advantageous in terms of energy consumption, investment, and production cost than conversion with oxygen. In terms of the current consumption characteristics and investment, the process of metal-steam conversion in a moving contact bed is most advantageous. 4 refs.
Chem. Yu.I. All-Union Scientific-Res Inst of Petroleum and Gas processing and for the Production of Liquid Synthetic Fuel, USSR. *Chem Technol Fuels Oil* v 7 n 9-10 Sep-Oct 1971 p 673-677.

HYDROGEN AND SYNTHESIS GAS PRODUCTION BY PARTIAL OXIDATION. Discussion of the experience acquired with the Shell gasification process which is being used in 18 countries for the manufacture of synthesis gas for ammonia, methanol, and oxo-alcohol synthesis. The development of ever-larger units, including waste heat boilers for high steam pressures, more versatile carbon recovery methods, and waste water treatment methods is described. 15 refs.

ter Haar, L.W. Shell Int Pet Maatsch. Hague, Neth. *Ingenieursblad* v 42 n 21 Nov 1 1973 p 586-592.

(ORNL-tr-2780) THERMAL DECOMPOSITION OF WATER IN CHEMICAL CYCLES OF THE Fe-Cl₂ FAMILY. Hardy-Grena, C. (Commission of the European Communities, Ispra (Italy). Joint Nuclear Research Center). [ed]. Translation by M. Gerrard of EUR-4956. 10p. Dep. NTIS \$3.00.

Thermal decomposition of water by chemical cycles is considered from the theoretical standpoint. From the thermodynamic conditions imposed (temperature limits of the operation cycle, free-energy-value limits for the different reactions that make up the cycle, etc.), only chlorine of the elements in Mendeleev's table can be considered as a reagent in the decomposition of water by an element. Based on this conclusion, a group of cycles was developed that use compounds of iron and chlorine. This Fe-Cl₂ family has the advantage of being based on common elements and having few problems of corrosion and pollution. (auth)

THERMOCHEMICAL SYSTEMS FOR

HYDROGEN GENERATION. This is a brief description of closed-cycle thermochemical hydrogen production, using water and heat as input ingredients and yielding hydrogen, oxygen and degraded heat as products through multistep reactions with cyclic chemical intermediates. This new system is compared to other methods of hydrogen generation including electrolysis, mixed-cycle, photolysis, and biological means.

Hanneman, R.E. GE Schenectady, NY; Wemhoff, R.H. Jr. *Am Chem Soc Div Fuel Chem. Prepr* v 18 n 3 for Meet Aug 26-31 1973 p 41.

N74-11731* Houston Univ. Tex.
PRODUCTION OF HYDROGEN
In its A Hydrogen Energy Carrier, Vol. 2 Sep. 1973 p 13-59
refs (For availability see N74-11728 02-33)
CSCIL 20M

Methods for producing hydrogen for a hydrogen economy are analyzed. Solar, wind, coal, and nuclear energies are considered as primary sources of energy for the electrolysis of water. Coal gasification processes are discussed along with thermochemical water decomposition by closed cycle processes. F.O.S.

N74-16810# Sandia Labs., Albuquerque, N.Mex.
ECONOMIC COMPARISON OF TWO SOLAR/HYDROGEN CONCEPTS
W. H. McCulloch, R. B. Pope, and D. O. Lee Oct. 1973 12 p
refs
(Contract AT(29-1)-789)
(SLA-73-900) Avail: NTIS HC \$3.00

Two concepts for producing hydrogen from solar energy are examined. The utilization of solar energy and the concept of a hydrogen fuel both have drawbacks. Solar energy is intermittent, interrupted by the diurnal cycle of available sunlight and by weather conditions. Most systems designed to use solar energy include an expensive energy storage mechanism to meet demands during periods when there is no incident solar radiation. Hydrogen generation plants would require large amounts of energy input. The concepts described utilize parameters typical of operation in Albuquerque, New Mexico. It is assumed that the collectors are positioned with the axes in a north-south plane, tilted 35 deg from the horizontal toward the south, with spacing between collectors equal to the collector dimensions. NSA

(LBL-2232) ELECTROCHEMICAL ASPECTS OF THE HYDROGEN ECONOMY. Meller, R. H. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Nov 1973. Contract W-7405-eng-48. 8p. (CONF-730848-2). Dep. NTIS \$3.00.

From international symposium and workshop on the hydrogen economy; Ithaca, New York, USA (19 Aug 1973).

Electrolytic hydrogen is too expensive for use as a general-utility fuel for the near-term. This conclusion is valid as long as carbonaceous materials, in the form of liquid or gaseous hydrocarbons, and in the form of coal in the future, are available for producing hydrogen or synthetic hydrocarbons. For the long-range future, water electrolysis is at present the only feasible, although imperfect, route to make hydrogen without the use of carbonaceous materials and discharge of carbon monoxide. For the medium-range future, a likely initial use of electrolytic hydrogen generation lies in the off-peak electrical energy storage. The chemical energy contained in the hydrogen may then be used as a source of heat or re-converted in the hydrogen to electrical energy. It appears that for a largely nuclear electrical power system there will be great need for off-peak energy storage. Improvements in water electrolysis for the production of hydrogen are necessary. (MCW)

Synthetic fuel energy systems based on fusion reactors: technology, economics, and environmental effects. J.R. Powell, F.J. Salzano, W.A. Seviran, K.C. Hoffman (Brookhaven Nat. Lab., Upton, N.Y., USA). *Trans. Am. Nucl. Soc. (USA)*, vol. 16, p.239-40 (June 1973). (1973 Annual Meeting of the American Nuclear Society (Summaries), Chicago, Ill., USA, 10-14 June 1973).

A synthetic fuel energy system based on hydrogen produced by large-scale fusion reactors is analyzed and presented as a technically and economically viable alternative to fossil fuels. Synthetic fuel production allows the use of very large, low-cost, base-loaded fusion reactors using DD or DT fuel cycles. (refs.)

CH-140.562

1973

HYDROGEN AND SYNTHETIC FUELS FOR THE FUTURE.

John W. Michel, ORNL. (Presented to the ACS Symp. on Chemical Aspects of Hydrogen as a Fuel, Chicago, Ill., Aug. 27-30, 1973). 35p. Draft. Reproduced from best copy available; portions are illegible.

American Chemical Society

Atomic Energy Commission

Conf-730807-3

Symposium on Chemical Aspects Aug. 27-30,

1973

of Hydrogen as a Fuel

Synthetic fuels can be produced at remote, well-regulated plants and would not contribute to the primary pollution problems that exist in urban centers. Production, storage, transportation, end uses, and overall systems analyses are evaluated for new fuel systems. Emphasis is on hydrogen and other fuels from nonfossil sources, but a section is included on the use of coal to produce hydrogen and methanol. Comparative characteristics of hydrogen, ammonia, hydrazine, methanol, methane, ethanol, and gasoline (C_8H_{18}) are tabulated. (JCW)

CENTRAL HYDROGEN PRODUCTION

FACILITY FOR A PETROCHEMICAL AREA.

Some of the factors associated with the design and selection of hydrogen plants, particularly large plants, are discussed. Various process flowsheets are reviewed for a wide range of feedstocks and hydrogen product purities. The effects of product purity, delivery pressure, and other major process parameters on the hydrogen product purity, and delivery pressure on overall operating costs is also dealt with. 5 refs.

Quarulli, O.J. Kellogg Int Corp. London. Eng. Cumbo, R.J.F. *Ingenieurblad* v 42 n 21 Nov 1 1973 p 593-605.

CATALYTIC DEHYDROGENATION OF COAL. Part

7. The Effect of Some Catalyst Variables. Reggel, L.; Wender, I.; Raymond, R. (Pittsburgh Energy Research Center). *Fuel*; 52: No. 3, 162-163(Jul 1973).

When vitrinite is catalytically dehydrogenated in the presence of phenanthridine as vehicle, the yield of hydrogen is not greatly influenced by the catalyst support or the concentration of metal on the support. The metal used has a large effect, palladium giving the highest yield of hydrogen. (auth)

TK2946. I55 1973

A73-39413 * # Electrolytic hydrogen fuel production with solid polymer electrolyte technology. W. A. Titterton and A. P. Fickert (General Electric Co., Lynn, Mass.). In: Intersociety Energy Conversion Engineering Conference, 8th, Philadelphia, Pa., August 13-16, 1973, Proceedings. (A73-38388 19-03) New York, American Institute of Aeronautics and Astronautics, Inc., 1973, p. 574-578, 6 refs. NASA-Navy-USAF-supported research.

A water electrolysis technology based on a solid polymer electrolyte (SPE) concept is presented for applicability to large-scale hydrogen production in a future energy system. High cell current density operation is selected for the application, and supporting cell test performance data are presented. Demonstrated cell life data are included to support the adaptability of the SPE system to large-size hydrogen generation utility plants as needed for bulk energy storage or transmission. The inherent system advantages of the acid SPE electrolysis technology are explained. System performance predictions are made through the year 2000, along with plant capital and operating cost projections. (Author)

(UCID-16298) NEW PROCESS FOR THERMOCHEMICAL DECOMPOSITION OF WATER USING PROCESS HEAT TO PRODUCE HYDROGEN. Ramsey, W. J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 20 Jun 1973. Contract W-7405-Eng-48. 17p. Dep. NTIS \$3.00.

Thermochemical estimates and experimental evidence lead to the conclusion that a lower-temperature cycle for hydrogen production from water is possible. Critical experiments must confirm the conclusion and heat flow, corrosion and economic questions need to be answered. One of the determining economic influences will be the mercury inventory required. This depends on quantities not yet measured. (22 references.) (MCW)

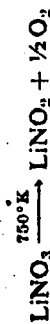
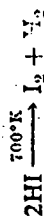
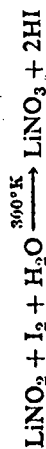
N74-16782* General Electric Co., Lynn, Mass. STATUS AND APPLICABILITY OF SOLID POLYMER ELECTROLYTE TECHNOLOGY TO ELECTROLYTIC HYDROGEN AND OXYGEN PRODUCTION W. A. Titterton In NASA. Lewis Res. Center Wind Energy Conversion Systems Dec. 1973 p 135-136 (For availability see N74-16757 08-03) CSCL 108

The solid polymer electrolyte (SPE) water electrolysis technology is presented as a potential energy conversion method for wind driven generator systems. Electrolysis life and performance data are presented from laboratory sized single cells (7.2 sq in active area) with high cell current density selected (1000 ASF) for normal operation. Author

A Low-Temperature Thermal Process for the Decomposition of Water

B.M. Abraham and F. Schreiner

Abstract. The following three reactions, each of which has been shown to proceed at the temperature indicated above the arrow, are suggested as a cycle for the thermal decomposition of water:



Science, v.180, 1973, p.959-960.

HYDROGEN PRODUCTION BY CATALYTIC STEAM REFORMING. Review of the latest technology in the production of pure hydrogen by catalytic steam reforming including shift conversion, CO₂-wash, and methanation. An outline of recent operating experience is presented, and programs and methods for the selection of optimum catalysts and steam reformer configurations are discussed. Economic aspects are also dealt with.

Voogd, J. Sels of Am (Ned). Hague, Neth. *Ingénieur* v 42 n 21 Nov 1 1973 p 579-585.

HYDROGEN PRODUCTION. This is a description, accompanied by the technological scheme, of petrochemical plant for the separation of hydrogen from hydrogen-containing dehydrogenation gases obtained during petroleum products modification in refineries. Detailed considerations are concluded with a statement that taking into account the simplicity of the plant for obtaining hydrogen from the hydrogen-containing gases of the dehydrogenation sections, it is worthwhile to build these plants, but not new plants for obtaining hydrogen by means of catalytic conversion with steam. Zhadanovskii, N.B. *Kubyshev Petroleum and Chemical Plants, USSR. Chem Technol Fuels Oils* v 8 n 1-2 Jan-Feb 1972 p 127-128.

THERMOCHEMICAL HYDROGEN GENERATION.

R.H. Wentorf, Jr. and R.E. Hammerman.

General Electric Co., Rept. 73CRD222, July 1973.

N74-19694 Escher Technology Associates, St. Johns, Mich. A PROBLEM STATEMENT: OCEAN BASED SOLAR-TO-HYDROGEN ENERGY CONVERSION MACRO SYSTEM William J. D. Escher and Joe A. Hanson (Oceanic Inst.) Nov. 1973 25 p refs

Copyright: Avail: Issuing Activity: CSCL 10A

An ocean based solar to hydrogen energy conversion facility is proposed that uses hydrogen as an energy carrier to be delivered to the spectrum of the energy using sector, instead of electricity, because of hydrogen's advantages of transportability and storability. The solar to hydrogen conversion process is conducted on the open ocean, and not in the traditional desert location. A number of coproducts that can also be supplied by the proposed ocean complex includes sea foods, salts, fertilizers, magnesium, and aluminum materials.

N74-16791* General Electric Co. Santa Barbara, Calif.
USE OF HYDROGEN AND HYDROGEN-RICH COMPO-
NENTS AS A MEANS OF STORING AND TRANSPORTING
ENERGY

Walter Hausz In NASA. Lewis Res. Center Wind Energy
Conversion Systems Dec. 1973 p 130-134 (For availability
see N74-16757 08-03)
CSCL 10C

A one-megawatt wind energy source is assumed that uses
half of its output to serve customers as electricity, and stores
the other half by conversion to hydrogen, to liquid hydrogen, to
stored LH₂, and back to electricity. Energy costs and capital
costs of the conversions escalate unit costs to 12.9 cents per
kilowatt hour. High conversion costs can be reduced by using
Mg₂NiH₄ and FeTiH₂ storage, or by using a 100- or 1000
megawatt system. G.G.

N74-16780* Oklahoma State Univ., Stillwater.
ENERGY STORAGE USING HIGH PRESSURE ELECTROLY-
SIS AND METHODS FOR RECONVERSION

William L. Hughes In NASA. Lewis Res. Center Wind Energy
Conversion Systems Dec. 1973 p 123-129 (For availability
see N74-16757 08-03)
CSCL 10C

Theoretical and experimental studies on high pressure
electrolysis producing hydrogen and oxygen for energy storage
and reconversion are reported. Moderate temperature, high
pressure hydrogen/oxygen fuel cells with nickel electrodes are
investigated for effects of pressure, temperature, and membrane
porosity. Test results from an aphodid burner turbine generator
combination obtained 40 percent kilowatt hours out of the fuel
cell divided by kilowatt hours into the electrolyzer. It is concluded
that high pressure hydrogenation of organic materials can be
used to synthesize hydrocarbons and methanes for making
synthetic vehicular fuels. G.G.

Macmillan, D. P., and Balcomb, J. D.,
"Nuclear Reactors for High Temperature
Process Heat - A Survey of Reactor
Types and Temperature Regimes", LASL
Paper LA-UR-73-877. Los Alamos
Scientific Laboratory, Los Alamos, N. M.,
Paper presented to the 166th National
A.C.S. Meeting, August 27, 1973.

Russell, J. H., Nutall, L. J., and
Fickett, A. P., "Hydrogen Generation
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Fujishima, A., and Honda, K., "Elec-
trochemical Photolysis of Water at a
Semiconductor Electrode", Nature, V.
238, pp 37-38, July 7, 1972.

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Eco-Energy", Publication 72TMP-53,
General Electric - TEMPO, Santa
Barbara, Calif., November, 1972.

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"Mollier Diagram for the Study of
Thermonuclear Water Splitting Proce-
ses", VDI Forsch-Heft, V. 38, n.
549, p. 25, 1972.

N73-33738# Atomic Energy Commission, Washington, D.C.
HYDROGEN AND OTHER SYNTHETIC FUELS: A SUMMARY OF THE WORK OF THE SYNTHETIC FUELS PANEL
Sep. 1972 135 p refs
(NTIS-281138) Avail: NTIS MF \$1.45; SOD HC \$2.25

The development of hydrogen as a synthetic fuel is attractive because it is essentially clean burning, the main combustion product being water; it may be substituted for nearly all fuel uses; it can be produced from domestic resources; it is available from a renewable and universal raw material-water; and nearly all primary energy sources, nuclear, solar, etc., may be used in its production. The main obstacles to the use of hydrogen as a universal fuel are its high cost relative to the current low prices for fossil fuels and, for some applications, the unresolved problems of handling a low-density or a cryogenic fluid. Safety considerations are discussed. The various options for the production of hydrogen, namely, electrolysis, thermochemical, biological, radiolytic, and various combinations, and the production of other synthetic fuels, particularly those made from hydrogen are discussed. Other synthetic fuels considered include ammonia (NH₃), hydrazine (N₂H₄), methanol (CH₃OH), methane (CH₄), ethanol (C₂H₅OH), and gasoline (C₈H₁₈). NSA

TITLE: Hydrogen Fuel Use Calls for New Source
CORPORATE AUTHOR: American Chemical Society
ADDRESS: 1155 Sixteenth St. NW, Washington, D.C.
20036

PUBLICATION DESCRIPTION: Chemical & Engineering
News, 50 (27), 16-18

PUBLICATION DATE: 1972, July 3

ABSTRACT: Technology to produce hydrogen is reviewed, including processes using steam reforming of natural gas, reforming of petroleum naphthas under pressure, partial oxidation of hydrocarbons, converting coal and coke to town gas, and electrolysis of water. Various methods of electrolysis are discussed in some detail. Economics will probably dictate whether hydrogen or another energy system will be used in the future.
(NPG)

Eastlund, B. J., and Gough, W. E.,
"Generation of Hydrogen by Ultra-Violet Light Produced by the Fusion Torch", Paper presented at the 163 National Meeting of the American Chemical Society, Boston, Mass., April 9-14, 1972.

Wiswell, R. H. Jr. and Reilly, J. J.,
"Metal Hydrides for Energy Storage".
Proceedings of 7th Intersociety Energy Conversion Eng. Conf. 1972, San Diego, Calif., Sept. 25-29, 1972.

HYDROGEN: TOMORROW'S FUEL?

N.P. Chohey.

Chem. Eng., v.79, Dec.25,1972, p.24-26.

It isn't going to happen soon, but hydrogen derived from water could eventually supplant all fossil fuels, as well as all electrical distribution networks.

CHEMICAL PROCESS TO DECOMPOSE WATER USING NUCLEAR HEAT. This is a description of a process of water conversion into hydrogen and oxygen by using the nuclear heat for operating some endothermal chemical reactions in a closed cycle, i.e. with nominal consumption of chemicals. In this method a four-step chemical cycle, christened Mark I, is employed with catalysts containing mercury, bromine and calcium. Results of chemical reaction studies involved in the Mark-I are presented, optimal structure of catalyst is elucidated, and economic considerations are included. 19 refs.

De Bont, G. C.C.R. Erection-lapa-Varese, Italy; Marchetti, C. *Ann Chem Soc Div Fuel Chem. Progr v 1* a 4 Pap for Meet Apr 10-14 1972 p 110-113.

N73-12132# European Atomic Energy Community, Ispa (Italy).
Joint Nuclear Research Center.
HYDROGEN PRODUCTION FROM WATER USING NUCLEAR HEAT Progress Report, period ending Dec. 1970
5 Jan. 1972 78 p refs
(EUR-4776e; PR-1) Avail: AEC Depository Libraries

Multistep chemical processes for the decomposition of water, using nuclear heat, are studied in view of producing hydrogen as an intermediate energy vector. The results of the work performed up to December 1970 are reported: the main object of the research is the Mark-1 cycle, the first patented chemical cycle. The studies are principally related to the chemistry (equilibria and kinetics studies and physicochemical properties), to the corrosion of construction materials, and to the preliminary flow-sheet determination for the coupling with a nuclear reactor. A general hydrogen market evaluation is also included.

Author (NSA)

1972

AUTOMATIC GENERATOR FOR PRODUCTION OF PURE HYDROGEN FROM METHANOL. Dixon, A. G.; Houston, A. C.; Johnson, J. K. (Shell Research Ltd., Chester, Eng.). pp 1064-1066 of 7th Intersociety Energy Conversion Engineering Conference, Washington; American Chemical Society (1972).

From 7th intersociety energy conversion engineering conference; San Diego, California, USA (25 Sep 1972). See CONF-720925-
TK 2896. ISS 1972

A fully automated unit was developed for the production of 4.25 m³/h (150 scfh) pure hydrogen by the catalytic steam reforming of methanol. Pure hydrogen was separated in a palladium/silver diffusion cell that was suspended integrally with the catalytic reactor in an externally heated fluidized bed with sand as a heat-transfer medium. The fluidized bed was heated by methanol combustion on startup and by combustion of the bleed gas from the diffusion cell after the operating-bed temperature (330°C) and pressure 18 to 20 bar (246 to 276 psig) were reached. Gross thermal efficiencies of 70 to 80% were observed at the rated output. The unit required no external services apart from a 22 to 30 V dc power supply for auxiliaries and control circuits. Power consumption under steady running condition was normally less than 130 W. Full-rated output was achieved in about 25 to 25 min from cold. Feed rate of aqueous methanol was automatically controlled by varying the pump speed as a combined function of temperature and pressure. Hydrogen storage allowed instantaneous step changes in demand to be met. (auth)

MACRO SYSTEM FOR THE PRODUCTION OF STORABLE, TRANSPORTABLE ENERGY FROM THE SUN AND THE SEA. The paper introduces and discusses a new energy system concept based on the synthesis of known subsystem approaches to create a "macro system" (large scale system-of-systems). This macro system employs solar energy to convert water to the energy form: cryogenic hydrogen and oxygen. This is deemed a feasible storable and transportable commodity for a wide variety of end-consumption means. The macro system will not produce environmental degradation in its operation, nor at that point of consumption. The approach offers distinct possibilities of cost-beneficial coproduction of other saleable products, although this aspect is not further developed in the paper. 22 refs.

Escher, William J.D. Escher Technol Assoc. St. John's Mich. Am Chem Soc. Div Fuel Chem. Prepr v 16 n 4 Apr 10-14 1972 p 28-47.

THERMODYNAMICS OF MULTI-STEP WATER DECOMPOSITION PROCESSES. Brief description of the process in which hydrogen is produced from water by thermal treatment in three or four steps in presence of such catalysts as tantalum, bismuth, mercury, or vanadium-chloride is followed by thermodynamic calculations. The following topics are discussed in detail—second law limitations; multi-step processes; work of separation; and the vanadium chloride process. Technological data are included. 5 refs.

Funk, James E. Univ of Kentucky. Lexington. Am Chem Soc. Div Fuel Chem. Prepr v 16 n 4 Apr 10-14 1972 p 79-87.

CS-129,277
HYDROGEN AS AN ENERGY VECTOR: NEW FUTURE PROSPECTS FOR APPLICATIONS OF NUCLEAR ENERGY.
G. Deght. 1972. 19p. (Document & M.F.).

European Atomic Energy Community EUR 4936 (Belgium)

(Water chemical decomposition using nuclear heat).

CS-140,245
POLLUTION-FREE ENERGY FROM OFFSHORE WINDS.
William E. Haronemus, Massachusetts U.
(Presented at the 8th Annual Conference and Exposition, Marine Technology Society, Washington, D.C., Sept. 11-13, 1972). 36p.

Marine Technology Society
 Massachusetts U.
 Marine Technology Society Conference Sept. 11-13, 1972
 and Exposition, 8th

Power sources, Wind
 Hydrogen
 Fuel cells
L-1-9-74

A72-38075 Large-scale concentration and conversion of solar energy. A. F. Hildebrandt, G. M. Haas, W. R. Jenkins (Houston, University, Houston, Tex.), and J. P. Colaco. EOS, vol. 53, July 1972, p. 684-692. 31 refs.

Description of a proposed solar energy power plant which first concentrates the solar energy and then applies a thermodynamic conversion cycle. A concentrator is proposed which consists of a large number of individual movable mirrors which reflect the solar energy onto a single collector atop a large tower. The concentrated energy can then be converted to electrical power either by means of a steam cycle, using liquid metals for heat transfer down the tower, or by a closed-cycle MHD generator; in this case preference is given to a closed-cycle MHD process employing an inert gas of helium with cesium seeding. The intermittent nature of the solar energy can be overcome by electrolyzing water into hydrogen and oxygen gas and storing the energy either in the form of compressed hydrogen and oxygen gas or as cryogenic liquids. Energy storage in the form of hydrogen is especially attractive, since it offers the possibility of a pollution-free fuel for the internal combustion engine. A.B.K.

Hydrogen production for better nuclear utilization. R. M. Thornton.
 Trans. Am. Nucl. Soc. (USA), vol. 15, no. 2, p. 27-8 (Aug. 1972). (Conference on Nuclear Power for Tomorrow. Summaries only, Atlantic City, N.J. USA, 22-25 Aug. 1972).
 One of the foremost restrictions placed on the rapid growth of nuclear power has been the economic necessity of using it as a base-load network. If the base load could be raised enough to "flatten" a utility's power demand curve, then nuclear systems could become the sole power-generation source for society. To promote this, a study into the feasibility of using off-peak electrical power from nuclear plants to produce hydrogen by electrolysis was made. The author discusses the economics of this idea and suggests possible uses for this new supply of hydrogen. (12 refs.)

330

De Beni, G. and Marchetti, C., "Mark 1, A Chemical Process to Decompose Water Using Nuclear Heat," Am. Chem. Soc. Div. Fuel Chem. Prepr. 16, No. 4, 110-20 (1972) April.

1972

N72-72521#

1971

TK2896. I55 1972

HYDROGEN-ELECTRIC UTILITY SYSTEM WITH PARTICULAR REFERENCE TO FUSION AS THE ENERGY SOURCE. Tanner, E. C. (Princeton Univ., NJ); Huse, R. A. pp 1323-1328 of 7th Intersociety Energy Conversion Engineering Conference, Washington, DC; American Chemical Society (1972). From 7th Intersociety energy conversion engineering conference; San Diego, California, USA (25 Sep 1972). See CONF-720525-
The use of hydrogen for large-scale energy storage, transmission, and distribution is discussed. A numerical example is given for one specific configuration—a fusion reactor linked to an electrolyzer plant. The advantages lie in the abundance of hydrogen, the low cost and high reliability of transmitting energy by pipeline, and the elimination of many constraints on plant siting. Problems arise from inefficiencies in electrolysis and in the reconversion of hydrogen to electricity. These inefficiencies result in more waste heat and drive up costs to the customers. Technological improvements can be expected that will lead to more efficient performances. (auth)

A72-34159 # Hydrogen generation by means of the aluminum/water reaction. I. E. Smith (Cranfield Institute of Technology; Cranfield, Beds., England). *Journal of Hydronautics*, vol. 6, July 1972, p. 106-109. 10 refs.

An aluminum amalgam will react with water at ordinary temperatures with the formation of aluminum hydroxide and the liberation of free hydrogen. In the case of a block or sheet of metal having an amalgamated surface, this reaction will continue until all the aluminum has been consumed. The reaction rate is observed to be temperature dependent, and this affords a simple means of regulating the output of hydrogen. If the supply of water and disposal of waste is discounted the reaction is shown to be superior, on a volumetric basis, to all other common means of producing hydrogen, and furthermore is competitive on a weight and cost basis with other chemical production methods. The inherent simplicity of such a scheme for hydrogen generation offers attractive advantages in terms of reliability. (Author)

A73-15818 * # Hydrogen gas generation in water/stainless-steel heat pipes. S. W. Patrick (California Institute of Technology, Jet Propulsion Laboratory, Engineering Mechanics Div., Pasadena, Calif.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Nov. 26-30, 1972, Paper 72-WA/HT-37.7*

p. Members, \$1.00; nonmembers, \$3.00. Contract No. NAS7-100.

(AED-CONF-71-100-18) APPLICATION OF NUCLEAR PROCESS HEAT FOR PROCESS TECHNIQUES. Schulten, R.; Kugeler, K.; Hansen, U.; Teuchert, E. (Kernforschungsanlage, Juelich (West Germany)). Institut fuer Reaktorentwicklung; Dueseldorf (West Germany). May 1971. 18p. (CONF-710901-522). Dep. NTIS (U. S. Sales Only).

From fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (8 Sep 1971).

The development of high-temperature reactors showed encouraging results in areas of contamination control and safety, so that an introduction of the high-temperature reactor into the general energy market appears feasible. These results show that low-cost nuclear reactor heat can be offered at temperatures up to 950°C and in the future to 1200°C. This will be reached by development of the once-through concept of the pebble-bed reactor. The fuel balls are continuously loaded at the top of the core under full power condition. They move slowly down to the bottom and reach their final burn-up during this irradiation period. In the upper part of the core, the fresh fuel yields a high power density, but the downward flow of cooling gas prevents the fuel temperature exceeding the design limits. In the lower core region there is only a moderate heat transfer to the coolant because of fuel depletion. The once-through pebble-system allows an increase in the average gas outlet-temperature to 950°C and higher. It is characterized by simplicity and flexibility in core layout and fuel cycle optimization. In the lower temperature region, such atomic power plants are able to produce steam and electricity; in the upper temperature region they are adapted for direct heat application. Processes which will be in question in the near future are discussed. These include production of superheated steam for chemical industries and refinery plants, production of hydrogen from natural gas and petrol, processing of heavy crude oil to hydrogen and to light hydrocarbons, production of olefins from petrol, and gasification of coal. (auth)

Partial oxidation. A minimum pollution route for hydrogen manufacture; W.G. SCHLINGER (Texaco, Inc., Montebello, Calif), W.L. SLATER; Amer Chem Soc, Div Petrol Chem, Prepr v 16 n 2 for meeting Los Angeles, Calif, Mar 28-Apr 2 1971 p C45-C50; Description of hydrogen manufacturing process which develops the major portion of the energy required for hydrogen generation by internal partial combustion of atmospheric contaminants from the combustion products, thereby minimizing the discharge of pollutants into the atmosphere. 3 refs. 38672

Destructive dehydrogenation of the aromatic ring; H.R. APPELL (U.S. Department of the Interior, Bureau of Mines, Pittsburgh, Pa.), R. RAYMOND, L. WENDER; Amer Chem Soc, Div Petrol Chem, Prepr v 16 n 2 for meeting Los Angeles, Calif, Mar 28-Apr 2 1971 p C24-C30; Results of an experimental program evaluating the possibility of obtaining hydrogen from aromatic hydrocarbons with the ultimate objective of applying this method to low cost hydrocarbons or bituminous materials such as residua, pitches and coal fractions, 7 refs. 39054

Commercial experience with hydrogen manufacturing catalyst; J.S. CROMEANS (Catalyst Consulting Services, Inc, Louisville, Ky), H. W. FLEMING; Amer Chem Soc, Div Petrol Chem, Prepr v 16 n 2 for meeting Los Angeles, Calif, Mar 28-Apr 2 1971 p C38-C44; Review of catalysts used in the production of hydrogen by the steam-hydrocarbon reforming process and by the partial-oxidation process. 10 refs. 39053

Modern hydrogen manufacture; D.K. BEAVON (Ralph M. Parsons Co, Los Angeles, Calif), T.R. ROSZKOWSKI; Amer Chem Soc, Div Petrol Chem, Prepr v 16 n 2 for meeting Los Angeles, Calif, Mar 28-Apr 2 1971 p C51-C66; 5 refs. 40415

Hydrogen for refining. Design and performance; R.N. BERY (Foster Wheeler Corp, Livingston, NJ); Amer Chem Soc, Div Petrol Chem, Prepr v 16 n 2 for meeting Los Angeles, Calif, Mar 28-Apr 2 1971 p C67-C76; 38752

Development of the hydrogen manufacturing process; A. LONGA-CRE (Fluor Corp, Los Angeles, Calif), H. TRUBY; Amer Chem Soc, Div Petrol Chem, Prepr v 16 n 2 for meeting Los Angeles, Calif, Mar 28-Apr 2 1971 p C32-C37; 15 refs. 40409

Direct production of hydrogen from coal-steam systems; E.J. MOFFMAN (Univ of Wyoming, Laramie); Amer Chem Soc, Div Petrol Chem, Prepr v 16 n 2 for meeting Los Angeles, Calif, Mar 28-Apr 2 1971 p C20-C23; 7 refs. 39353

Production of hydrogen from coal char in an electrofluid reactor; A.N. PULSIFER (Iowa State Univ, Ames), T.D. WHEELLOCK; Amer Chem Soc, Div Petrol Chem, Prepr v 16 n 2 for meeting Los Angeles, Calif, Mar 28-Apr 2 1971 p C5-C19; 13 refs. 38993

Production of hydrogen involving multi-state partial oxidation and reforming; L.A. VORUM; Amer Chem Soc, Div Petrol Chem, Prepr v 16 n 2 for meeting Los Angeles, Calif, Mar 28-Apr 2 1971 p C31; 39065

D. P. Gregory, D.Y.C. Ng, G. M. Long
"Electrolytic Hydrogen As A Fuel", Institute
of Gas Technology, January 1971.

(NP-19323) OBTAINING HYDROGEN BY MEANS OF REACTOR HEAT. Domeser, Stefan (Kernforschungszentrum, Karlsruhe (West Germany)). Institut fuer Neutronenphysik und Reaktortechnik. Oct 1971. 66p. (In German). Dep. NTIS (U. S. Sales Only).

Known methods used in the decomposition of water by means of reactor heat are discussed. Theoretical considerations on the development of new methods show that closed-circuit processes with gas components require relatively high temperatures and, therefore, seem to be not very promising. The production of hydrogen by dissolution of the metal and the subsequent conversion into oxide call for a low decomposition temperature of the oxide. Experiments were made with reactions in the molten state in order to convert into oxides the halogenides formed in the closed-circuit process. With a view to complete the closed-circuit processes, exchange reactions and separations through evaporation of some alkaline and alkaline earth halogenides, respectively, and the metals in the Vb-group of the periodic system were checked experimentally. Some considerations were made with respect to economy. (auth)

A POTENTIAL LARGE SCALE PLASMA PROCESS: SYNTHESIS OF INEXPENSIVE HYDROGEN BY USING A THERMONUCLEAR DEVICE TO VAPORIZE WASTE ORGANIC MATERIALS.

D.R. Safrany.

Chem. Eng. Sym. Ser., v.67, no.112, 1971, p.103-8.

Solar energy is stored as carbohydrates since these are produced via photosynthesis. This energy could be used to lower the cost of fixing nitrogen by the Haber process, by perhaps an order of magnitude, if the carbohydrates could be converted inexpensively to hydrogen and carbon monoxide. This might be accomplished by vaporizing with a thermonuclear device, and thus driving to thermodynamic equilibrium, large masses of organic waste materials, for example, sewage, lignin, etc. By using a contained nuclear explosion, hydrogen might be produced for considerably less than 1¢ and ammonia for 1/10 ¢/lb.

SOME COMMENTS ON THE POSSIBILITY OF THERMODYNAMICALLY EQUILIBRATING WASTE ORGANIC MATERIALS WITH NUCLEAR DEVICES. Safrany, David R. (Bechtel Corp. Lab., Belmont, Calif.). Nucl. Technol.; 12: No. 1, 119-26 (Sep 1971).

Nuclear explosions contained underground may be a way to produce hydrogen commercially from common waste organic materials. The idea is to use the explosion to heat the wastes to 2000°C or higher, at which temperatures hydrogen and carbon monoxide are produced. Carbon monoxide can subsequently be converted to tritium-free additional hydrogen by oxidizing it with steam. The pertinent thermodynamic equilibria, kinetics and energy requirements are discussed. (auth)

N72-18520# Energy Research Corp., Bethel, Conn.
HYDROGEN GENERATOR ASSEMBLIES Final Report,
Mar. 1970 - Mar. 1971

Richard Engdahl and E. S. Tillman, Jr. Sep. 1971 70 p refs
(Contract DAA807-70-C-0153; DA Proj. 1G6-63702-DG-10)
(AD-733931; ECOM-0153-F) Avail: NTIS CSCL 13/7

The objective of the work was to evaluate design criteria for a simplified hydrogen generator for a 500 watt fuel cell. The hydrogen is produced by the catalytic steam reforming of vaporized JP-4 fuel with subsequent purification through a palladium-silver separator. The experimental studies were performed on a breadboard type system. This system contained all of the major sub-components required in an actual portable unit for field use.

GRA

Process heat from high temperature reactors

Bode, K. H., and Schlosser, J., Brown Boveri Nachr., 53, (9/10), 259-266, (1971).
(In German). The utilization of nuclear heat for the conversion of fossil raw material requires temperatures of 800-1100°C which only a high temperature reactor can supply. Methane decomposition and direct gasification of coal are regarded as the most profitable and both brown and bituminous coals could be used; it would in part depend on the production costs of hydrogen and use of cheap nuclear heat would assist in this. Use of the conversion products is discussed.

C

THE PRODUCTION OF LIQUID HYDROGEN AT THE ROCKET
PROPULSION ESTABLISHMENT. R. BAINBRIDGE AND T.R.
HORTON.

Cryogenics, v.11, no.6, Dec.1971, p.456-468.

The design, development, and operation of a liquid hydrogen plant with an hourly output of 100 liters of normal liquid hydrogen or 70 liters of 85-90% para-hydrogen are described.

A72-33890 Thermo-catalytic hydrogen generation from hydrocarbon fuels. M. A. Callahan (U.S. Army, Engineer Research and Development Center, Fort Belvoir, Va.). In: From electro-catalysis to fuel cells; Proceedings of the Seminar, Seattle, Wash., December 9-11, 1970. (A72-33876 16-03) Seattle, University of Washington Press, 1972, p. 189-204. 13 refs.

The catalyzed pyrolysis of liquid hydrocarbon fuels is shown to be a feasible method of generating high-purity hydrogen. The advantages of this method over other hydrogen production systems, such as steam reforming, are notably its simplicity, its tolerance to fuel additives, and the purity of the product. The cracking reaction can be made to be close to 100% efficient in hydrogen yield, with a stream purity of greater than 95% hydrogen. The problems associated with this method of hydrogen generation are the high temperatures needed and undesired side reactions.

D.F.L

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72N72164# BNL-16259 CONF-711035-1

70/00/00 6 PAGES

UNCLASSIFIED

DOCUMENT

HYDROGEN FOR ENERGY TRANSPORT AND STORAGE IN SOLAR ENERGY SYSTEMS

A/HOFFMAN, K. C.; B/WINSCHKE, W. E.

BROOKHAVEN NATIONAL LAB., UPTON, N.Y.

SPONSORED BY AEC PRESENTED AT THE 3D CONF. ON LARGE SCALE SOLAR ENERGY CONVERSION FOR TERRESTRIAL USE, NEWARK, DEL., 9 OCT. 1971

/♦ENERGY TRANSFER♦HYDROGEN♦SOLAR ENERGY STORAGE/ SOLAR

ENERGY ABSORBERS/ SOLAR GENERATORS

1969

Geanfranco De Beni and Cesare Marchetti,
"Hydrogen Key to the Energy Market," Euro Spec-
tra, p. 46-50, June 1970.

1969

Mrochek, J. E., "The Economics of
Hydrogen and Oxygen Production by
Water Electrolysis and Competitive
Processes", in Grigorjeff, W. W., ed.,
Abundant Nuclear Energy, pp 107-22,
U.S. Atomic Energy Commission, Wash.
D. C., 1969.

N70-14511# Oak Ridge National Lab., Tenn.
THE ECONOMICS OF HYDROGEN AND OXYGEN
PRODUCTION BY WATER ELECTROLYSIS AND
COMPETITIVE PROCESSES

J. E. Mrochek In AEC Abundant Nucl. Energy May 1969
p 107-122 refs (See N70-14504 04-22)
Avail. CFSTI.

The manufacturing costs of hydrogen and oxygen are
estimated for water-electrolysis plants using two types of advanced
electrolytic cells: porous-electrode cells and high-temperature
vapor-phase cells. Electrolytic plants producing 40 million standard
cubic feet of hydrogen and 860 tons of oxygen per day are
compared with fossil-fuel plants that use steam reforming and
partial-oxidation processes at the same hydrogen-production rates.
The cost of electricity required for the electrolytic process using a
porous-electrode cell to break even with the fossil-fuel processes
ranged from 0.8 to 2.3 mills/kw-hr. If an oxygen credit of \$4/ton
was assumed, this break-even power cost range increased to 1.5
to 3 mills/kw-hr. The use of electrolytic hydrogen plants as
load-leveling devices for power plants is discussed briefly.

Author (NSA)

Hoffman, K. C. et al, "Metal Hydrides
as a Source of Fuel for Vehicular
Propulsion", paper SAE 690232 pre-
sented at the International Auto-
motive Engineering Conference, Detroit,
January 13-17, 1969.

METHANE CRACKING BY NUCLEAR REACTOR HEAT.
Schulten, R.; Kugeler, K. (Kernforschungsanlage, Juelich, Ger.).
Chem.-Ing.-Tech., 41: 1132-3(Oct. 1969). (In German).

A method for the cracking of methane using heat from the be-
limum of a pebble bed reactor was proposed. Reaction equations
and thermodynamic data indicate that almost all the methane
would be converted into hydrogen and carbon dioxide. An instal-
lation for such a cracking procedure was sketched. Cost esti-
mations using reactor heat for methane cracking were compared
with chemical processes. The data are tabulated, and the cost
of the hydrogen produced is given as a function of the CH₄ price.
(J.S.R.)

N69-28227# Air Products and Chemicals, Inc., Allentown, Pa.
STUDY, COST, AND SYSTEM ANALYSIS OF LIQUID
HYDROGEN PRODUCTION Final Report

N. C. Hallett Jun. 1968 323 p refs
(Contract NAS2-3894)

(NASA-CR-73226) CFSTI: HC\$3.00/MF\$0.65 CSCL 07A

This report contains information related to contemplated
large-scale liquid hydrogen systems. Descriptions of feasible
processes and equipment are presented. Information concerning
availability and cost of required raw materials and energy are
projected. Composite system analyses based on preliminary NASA
hypersonic transport (HST) liquid hydrogen requirements indicate
estimated average product cost of 7.7 to 8.8 cents per pound.

Author

"A Wind Energy Storage Technique Utilizing a Hydrogen-Oxygen Electrolysis Cell System" by H. Jack Allison, 1968, presented at the Frontiers of Power Technology Conference, Oklahoma State University.

TK2896.I55 1967

USE OF ENERGY STORAGE WITH UNCONVENTIONAL ENERGY SOURCES TO AID DEVELOPING COUNTRIES.

K.A. McCollom.

Advances in Energy Conversion Engineering, 1967
Intersociety Energy Conversion Engineering Conference,
Aug.13-17, 1967, Miami Beach, Fl., p.813-819.

Development of an energy storage system using electrolysis of water to produce hydrogen and oxygen has led to an investigation of the use of unconventional energy sources in assisting developing countries

1967

N67-24674# Allis-Chalmers Mfg. Co., Milwaukee, Wis.
DESIGN STUDY OF HYDROGEN PRODUCTION BY
ELECTROLYSIS, VOLUME I Final Technical Report, Mar.
1-Jun. 30, 1966

Oct. 1966 54 p Prepared for Oak Ridge Natl. Lab.
(Contract W-7405-ENG-28)
(ACSDS-0106643, Vol. I; TID-23439, Vol. II) CFSTI: HC \$3.00/MF
\$0.65

The design study of hydrogen production by electrolysis, was centered around low capital investment as the primary goal, with other factors, such as high efficiency, long life, simple, trouble-free operation, maintenance and down time also influencing the conceptual system. Only uncatalyzed porous nickel electrodes were considered. Two electrolysis plant sizes were considered during the conceptual phase of the study 4,400 pounds of hydrogen per hour (equivalent to 300 tons of ammonia per day) and 44,000 pounds of hydrogen per hour (equivalent to 3,000 tons of ammonia per day). The hydrogen is to be delivered at 3,000 psig directly to an ammonia plant. Preliminary estimates made early in the program comparing low pressure (300 psig) and high pressure (3,000 psig) electrolysis plants indicated that high-pressure system capital costs would be economically unattractive all subsequent systems studied were at 300 psig. Three hydrogen plants were studied in this program and cost estimates were prepared for their total installation and operation. The plants were evaluated as to their subsystems and the costs for all their components. NSA

1967

ELECTROLYSIS AS A SOURCE OF HYDROGEN AND OXYGEN.

R.L. Costa and P. G. Grimes.

Chem. Eng. Prog. Sym. Ser., v.63, no.71, 1967,
p.45-58.

N67-24672# Allis-Chalmers Mfg. Co., Milwaukee, Wis.
DESIGN STUDY OF HYDROGEN PRODUCTION BY
ELECTROLYSIS, VOLUME II Final Technical Report, Mar.
1-Jun. 30, 1966

Oct. 1966 171 p Prepared for Oak Ridge Natl. Lab.
(Contract W-7405-ENG-28)
(ACSDS-0106643, Vol. II; TID-23439, Vol. II) CFSTI: HC
\$3.00/MF\$0.65

Drawings, preliminary specifications, and cost estimates for the electrolytic production of hydrogen are presented. NSA

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A67-20288 #

STORAGE OF SOLAR ELECTRICAL ENERGY BY ELECTROLYSIS OF WATER, SEPARATE STORAGE OF COMPRESSED HYDROGEN AND OXYGEN, AND SUBSEQUENT RECOMBINATION OF THESE GASES BY FUEL CELLS.

E. Justi and W. Kaibler (Braunschweig, Technische Hochschule, Institut für technische Physik, Braunschweig, West Germany).

(Coopération Méditerranéenne pour l'Energie Solaire, Rencontre Générale de Printemps, Université de Marseille, Marseille, France, May 19-25, 1966, Article.)

Coopération Méditerranéenne pour l'Energie Solaire, Bulletin no. 11, Dec. 1966, p. 105-114.

Discussion of the collection of solar energy by means of hydrogen fuel cells operating at ambient temperature and pressure, with high efficiency and power density, with water as the harmless final reaction product. Only such common metals as nickel and silver are used as catalysts, and methods have been found to increase their catalytic activity according to Raney's methods. The electrodes described have a double skeleton. A new three-electrode storage cell and an experimental demonstration model are described. The energy and efficiency of storing is considered.

J

F.R.L.

N64-25524 General Motors Corp., Indianapolis, Ind. Allison Div.

ENERGY DEPOT ELECTROLYSIS SYSTEMS STUDY Final Report

C. W. Schade, R. A. Foust, Jr., B. N. Thomson, M. J. Mulik, W. L. Carr et al 1 Jun. 1964 219 p refs (Contract AT(30-1)-3101) (EDR-3714, Vol. 1)

The conceptual design of an efficient, lightweight, rugged, and compact mobile electrolysis unit for the production of hydrogen from water was evolved. The conceptual chemical plant will produce 7.15 T/day of anhydrous ammonia with a power source of 3000-kw supplied at 4160 v, 3-phase, and 60 cps. The chemical plant is composed of three transportable skids, each weighing 30,000 lb or less. Catalytic electrodes were developed that are highly efficient in terms of power required to dissociate water into hydrogen and oxygen. Both acid and base systems were investigated. Detailed studies were made of power conditioning equipment, liquid gas separators, and overall system optimization. Engineering drawings of a conceptual electrolysis unit and detail drawings of a prototype electrolysis module were a part of this study. Experiments to determine the effect of impurities from corrosion products or impure feed water are reported.

Author:

74N71383 EDR-3714-VOL-2 AT(30-1)-3101
UNCLASSIFIED DOCUMENT

ENERGY DEPOT ELECTROLYSIS SYSTEMS STUDY FINAL REPORT
A/FUNK, J. E.; B/HIRT, T. J.

GENERAL MOTORS CORP., INDIANAPOLIS, IND. (ALLISON DIV.)

AVAIL. NTIS

♦GAS GENERATORS/♦HYDROGEN/♦THERMAL ENERGY/ AIR/ AMMONIA/ CHEMICAL REACTIONS/ WATER

335

ENERGY REQUIREMENTS IN THE PRODUCTION OF HYDROGEN FROM WATER. J.E. Funk and R.M. Reinstrom. Industrial & Engineering Chem. Process Design & Development, v.5, no.3, July 1966, p.336-342.

Hydrogen production from water energy requirements are discussed from a theoretical point of view. While water decomposition process is more efficient (on a thermal energy basis) than electrolysis none is available at present.

N64-24895 General Motors Corp., Indianapolis, Ind. Allison Div.

ENERGY DEPOT ELECTROLYSIS SYSTEMS STUDY Final Report

J. E. Funk and R. M. Reinstrom 30 Jun. 1964 83 p refs (Contract AT(30-1)-3101) (EDR-3714, Vol. 11, Suppl. A)

The results presented show that the ideal efficiency of a constant temperature and pressure chemical process that produces hydrogen from water is exactly the same as the ideal efficiency of an electrolysis process operated at the same temperature and pressure. It is further shown that there are inefficiencies in a chemical process that cannot be avoided. The fact is established that the reactions in a chemical process cannot be run at a single temperature if the process is to be more efficient than electrolysis. Specifications for compounds, which would yield efficient two-reaction chemical processes, have been developed. They appear in the form of free energy of formation and absolute entropy difference between the hydride or oxide of the compound and the compound itself. The absolute entropy change that occurs when either an oxygen atom or two atoms of hydrogen are added to a molecule can be determined semiempirically. These semiempirical correlations indicate that only certain gaseous compounds can meet the entropy specification.

Author:

1963

N63-19875 P. E. C. Corp. Boulder, Colo.
 INVESTIGATION FOR THE PURPOSE OF IMPROVING THE
 EFFICIENCY OF UTILIZATION OF SOLAR ENERGY BY THE
 DECOMPOSITION OF WATER INTO HYDROGEN AND OXY-
 GEN [Final Report 1 May 1961-30 Apr. 1963]
 Ronald E. West, Hosmoz Mahmoud, Donald G. Burkhard,
 Harumasa Ito, and Robert S. Kirk May 1963 144 p 91 refs
 (Contract AF 19(604)-8420)
 (AFCRL-63-666)

The sensitized photo-decomposition of water has been studied, with the purpose of improving its efficiency as a means of solar-energy conversion. A number of metallic cations and other materials were tested for sensitizer activity and, of these, only ceric, thallic, ferrous, iodide, and chromous ions do sensitize the reaction, the former two to yield oxygen, the latter three, hydrogen and oxygen observed. Quantum yields were determined, with substantial conversion of the sensitizer, and found to be of the order of 10^{-2} to 10^{-4} . Initial yields were much higher. With the known sensitizers, this reaction does not utilize a sufficient fraction of the solar spectrum to be practical as a means of solar-energy conversion. Several mixtures of ions and also various solid materials as additives to sensitizer solutions were tested for their influence on sensitizer activity. In every case, it was found that the quantum yield was the same as or lower than with the sensitizer alone.

Author

1962

ENERGY STORAGE PROBLEMS.

F. Daniels.

Solar Energy, v.6, no.3, July/Sept.1962, p.78-83.

Sections on mechanical storage, storage batteries, fuel cells, hydrogen fuel (electrolysis), chemical and photochemical energy storage, heat storage, and electrical network.

Von Fredersdorff, C. G., "Conceptual Process for Hydrogen and Oxygen Production From Nuclear Decomposition of Carbon Dioxide," Memorandum to Project S-128 Sponsors' Committee. Chicago: Institute of Gas Technology, October 30, 1959.

Economic Value of Hydrogen Produced by Wind Power, A.H. STODOLSKY, ~~Brit. Elec. & Allied Industries Research Assn.~~ Tech Report C/T111 1964 8 p. Circumstances under which possible use of windpower to produce hydrogen might be considered; estimated costs of providing heat, light and power in this way are compared with those of obtaining energy in similar forms by use of either paraffin or diesel oil; examples based on cost of fuel at semi-desert site and at Island site are given.

1974

ALTERNATE FUELS FOR TRANSPORTATION. PART 1: HYDROGEN FOR AIRCRAFT.

W.J. Small, D.E. Fetterman, and T.F. Bonner, Jr. (LSC)
Mechanical Engineering, v.96, no.5, May.1974,
p.18-24.

Liquid hydrogen has great potential as an aviation fuel because of its high energy content and cooling capacity, its minimal environmental impact, and its potentially unlimited supply. Its use as a fuel will greatly improve the performance of subsonic aircraft and supersonic aircraft. Hydrogen fuel could make possible hypersonic transports.

1974

ALTERNATE FUELS FOR TRANSPORTATION: PART 2: HYDROGEN FOR THE AUTOMOBILE.

W.F. Stewart and F.J. Edesky.
Mech. Engineering, v.96, no.6, June 1974, p.22-28.

Hydrogen may be an excellent replacement for the world's dwindling automotive gasoline supply. It offers an unlimited pollution-free closed-cycle system when produced by the electrolysis of water and burned with O₂. Conventional internal-combustion engines have been operated on hydrogen fuel with almost no pollution and with increased engine efficiency. An even greater reduction of pollution and a higher engine efficiency can be provided by an engine designed specifically for hydrogen fuel. Problem areas: storing and refilling of H₂ fuel tanks and developing an overall H₂ production and distribution system.

1974

Cryogenics & Industrial Gases, v.9, no.1, Jan/Feb.1974.

Hydrogen's potential as an automotive fuel23

Billings Energy Research recently handed over to reporters the keys to a hydrogen-powered Chevrolet and let them judge the potential of this alternate energy source. While there are still hurdles to be jumped, this company's president says a strong and immediate push could make the day of hydrogen-fueled autos arrive reasonably soon.

HYDROGEN AGE ROLLS FORWARD.

Mech. Engineering, v.96, no.3, Mar.1974, p.40-41.

Hydrogen has spurted into the lead, if only temporarily, in a 1973 Chevrolet Monte Carlo known as the HL-1.

A74-19353 # Hydrogen - Make-sense fuel for an American supersonic transport. W. J. D. Escher (Escher Technology Associates, St. Johns, Mich.) and G. D. Brewer (Lockheed-California Co., Burbank, Calif.). American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-163. 11 p. 21 refs. Members, \$1.50; nonmembers, \$2.00.

Arguments in favor of the use of liquid-hydrogen fuel for power supersonic transport aircraft are presented, with a view toward the 'better and faster' SST the U.S. will eventually build. It is seen that, in addition to the economic and operational advantages, the use of hydrogen will establish a sound basis for evolving out of the present self-limited petroleum era into tomorrow's hydrogen economy. V.P.

1974

THE CASE FOR THE HYDROGEN FUELED TRANSPORT AIRCRAFT.
G.D. Brewer.

Aeronautics & Astronautics, v.12, no.5, May 1974,
p.40-51.

Hydrogen's potential supply and its performance characteristics match the forecast needs of aviation, and this industry's practitioners will know how to introduce it expeditiously and pave the way for its wider industrial use.

(BNL-18719) APPLICATION OF METAL HYDRIDES
TO GROUND TRANSPORT. Walde, C. H.; Reddy, J. J.; Wainall,
R. H. (Brookhaven National Lab., Upton, N. Y. (USA)). 1974.
11p. (CONF-740306-10). Dep. NTIS \$4.00.

From hydrogen economy Miami energy conference; Miami
Beach, Florida, USA (18 Mar 1974).

Hydrogen, an alternative to gasoline fuel in vehicle applications,
can be stored as a metal hydride and released for use by the appli-
cation of waste heat from the engine. Present investigations include
a review of known and possible hydrides with a potential for auto-
motive use. Hydride bed types and their application to vehicles
are discussed. FeTiH_2 and MgH_2 are considered. Their merits
and potential for use in meeting various transportation needs are
discussed. Implementation through fleet vehicle systems is pro-
posed as a means of gaining practical experience with reasonable
control during the introduction of the advanced technology. (auth)

74N22600# ISSUE 13 PAGE 1617 CATEGORY 34 74/00/00 139 PAGES
UNCLASSIFIED DOCUMENT

RESEARCH ON GROUND PROPULSION SYSTEMS

COMMITTEE ON SCIENCE AND ASTRONAUTICS (U. S. HOUSE). AVAIL:

SUBCOMM. ON SPACE SCI. AND APPL.

WASHINGTON GPO HEARINGS ON H.R. 10392 BEFORE COMM. ON SCI. AND
ASTRONAUT., 93RD CONGR., 2D SESS., NO. 26, 4-6 FEB. 1974

/♦CONGRESS/♦ENERGY POLICY/♦PROPULSION SYSTEM
CONFIGURATIONS/♦PROPULSION SYSTEM PERFORMANCE/ ENVIRONMENTAL QUALITY/
HYDROGEN-BASED ENERGY/ RESEARCH AND DEVELOPMENT

1974

(BNL-18720) MODELING STUDIES OF FIXED-BED
METAL-HYDRIDE STORAGE SYSTEMS. Yu, W. S.; Sumburg, E.;
Walde, C. (Brookhaven National Lab., Upton, N. Y. (USA)). 1974.
14p. (CONF-740306-11). Dep. NTIS \$4.00.

From hydrogen economy Miami energy conference; Miami
Beach, Florida, USA (18 Mar 1974).

Modelling studies are of a practical importance in understand-
ing and characterizing the behavior of hydride beds now being
developed for storing and supplying hydrogen fuel in power plant
and automotive applications. A convection bed model, in which
heat is transferred to or from the bed by a flowing stream of
hydrogen in direct contact with the particles, and a conduction
model in which heat is transferred through a containment wall,
were developed. FeTiH_2 and catalyzed MgH_2 were evaluated using
the model. (auth)

THE STORAGE OF HYDROGEN AS METAL HYDRIDES.

D.L. Cummings and G.J. Powers.

Ind. Eng. Chem., Process Des. Develop., v.13, no.2,
1974, p.182-192.

Metal hydrides offer a reversible, chemical means
for storage of hydrogen and could be used as mobile
and stationary fuel sources. The properties and uses
of metal hydrides are reviewed. A magnesium hydride
bed, used in a hydrogen-powered automobile, is
modelled.

THE HYDROGEN ECONOMY MIAMI ENERGY (THEME) CONFERENCE.

Presented by The School of Engineering &
Environmental Design, Univ. Miami, Coral
Cables, Florida.

Sponsored by The National Science Foundation,
Defense Advanced Research Projects Agency,
and The School of Continuing Studies, Univ.
of Miami.

Miami Beach, Florida, Mar.18-20,1974.

**ENGINE PERFORMANCE WITH GASOLINE AND
HYDROGEN FUELS: A COMPARATIVE STUDY**

J. G. Finegold, W. D. Van Vorst, University of
California, Los Angeles, California

AN INVESTIGATION OF THE IGNITION CHARACTERISTICS OF H_2 - O_2 - N_2 MIXTURES

G. A. Karim, M. Rashidi, M. D. Souza, University
of Calgary, Alberta, Canada

BACKFIRE CONTROL TECHNIQUES FOR HYDROGEN FUELED INTERNAL COMBUSTION ENGINES

F. Lynch, Energy Research Corporation, Provo,
Utah

**THE HYDROGEN/METHANOL - AIR BREATHING
AUTOMOBILE ENGINE**

R. R. Adt, H. Greenwell, M. R. Swain, University
of Miami, Coral Gables, Florida

CATALYTIC COMBUSTION OF HYDROGEN

G. E. Laramore, J. E. Houston, R. L. Park, Sandia
Laboratories, Albuquerque, New Mexico

AIR FORCE EXPERIENCE OF HYDROGEN AS PROPULSION FUEL

B. Dunnam, Air Force Aero Propulsion Laboratory,
Wright Patterson AFB, Ohio

**INVESTIGATION OF HYDROGEN FUEL FOR
NAVAL VEHICLES**

E. Quandt, Naval Ship Research and Development
Center, Bethesda, Maryland

ARMY VIEW OF HYDROGEN ENERGY

R. Quillian, Southwest Research Institute, Ft.
Worth, Texas, D. Weidhauer, Army Materiel Command,
Arlington, Va.

HYDROGEN FOR SUBSONIC TRANSPORT

P. F. Korycinski, National Aeronautics and Space
Administration, Langley Research Center, Hampton,
Virginia

**LIQUID HYDROGEN AS A FUEL FOR FUTURE
COMMERCIAL AIRCRAFT**

R. D. Lessard, United Aircraft Research Laboratories,
East Hartford, Connecticut

THE HYDROGEN ECONOMY MIAMI ENERGY (THEME) CONFERENCE.

Presented by The School of Engineering &
Environmental Design, Univ. Miami, Coral
Gables, Florida.
Sponsored by The National Science Foundation,
Defense Advanced Research Projects Agency,
and The School of Continuing Studies, Univ.
of Miami.
Miami Beach, Florida, Mar. 18-20, 1974.

Hydrogen Storage in Vehicles

Session Chairman: L. W. Jones,
University of Michigan,
Ann Arbor, Michigan

Session Co-Chairman: J. Alexander,
University of Miami,
Coral Gables, Florida

**AMMONIA AS A HYDROGEN CARRIER AND ITS
APPLICATION IN A VEHICLE**

R. L. Graves, J. W. Hodgson, J. S. Tennant, The
University of Tennessee, Knoxville, Tennessee

**METAL HYDRIDES: EXPERIMENTAL METHODS
AND APPLICATION TO THE ELECTRIC VEHICLE**

P. Jonville, H. Stohr, R. Funk, M. Kornmann,
Battelle Centre de Recherche de Geneve, Geneva,
Switzerland

**THE APPLICATION OF METAL HYDRIDES TO
GROUND TRANSPORT**

C. H. Waide, K. C. Hoffman, J. J. Reilly, R. H.
Wiswall, Brookhaven National Laboratory, Long
Island, New York

**HYDROGEN STORAGE FOR AUTOMOBILES USING
METAL HYDRIDES AND CRYOGENICS**

R. E. Billings, Energy Research Corporation,
Provo, Utahs,

**STUDIES OF THERMAL STRATIFICATION IN LH₂
AUTOMOTIVE FUEL TANKS**

K. D. Williamson, Jr., J. R. Bartlit, F. J. Edeskuty,
W. F. Stewart, Los Alamos Scientific Laboratory,
University of California, Los Alamos, New
Mexico,

HYDROGEN FUEL?

Flight International, Jan.3,1974, p.4.

Hydrogen fueled aircraft.

ON-BOARD GENERATOR SUPPLIES HYDROGEN FOR I-C ENGINE.

J. Houseman and D.J. Cerini., JPL.

Automotive Engineering, v.82, no.3,
Aug.1974, p.42-50.

A compact on-board hydrogen generator has been developed for use with a hydrogen-enriched gasoline i-c engine. The unit uses gasoline and air in a partial oxidation reactor to produce a gaseous product containing hydrogen, carbon monoxide, minor amounts of methane, carbon dioxide, water, and nitrogen.

A73-37498 * # Turbojet emissions - Hydrogen versus JP. J. Grobman, C. Norgren, and D. Anderson (NASA, Lewis Research Center, Cleveland, Ohio). *Working Symposium on Liquid-Hydrogen-Fueled Aircraft*, Hampton, Va., May 15, 16, 1973, Paper. 22 p. 20 refs.

Preliminary data from an experimental combustor show that the NO sub x emission index, g (NO₂)/kg fuel, is about three times greater for hydrogen than for JP at simulated cruise conditions. However, if these results are applied to aircraft designed for a given mission, hydrogen's higher heating value enables the aircraft to have a lower gross weight and a lower fuel flow rate so that the NO sub x emission rate, kg(NO₂)/hr may be reduced about 30% compared to JP. Theoretical kinetics calculations indicate that combustors may be designed for hydrogen that could further decrease NO sub x emissions by taking advantage of hydrogen's wide flammable limits and high burning velocity. (Author)

A74-18797 * # The jet engine design that can drastically reduce oxides of nitrogen. A. Ferri and A. Agrone (New York University, Bronx, N.Y.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 12th, Washington, D.C., Jan. 30-Feb. 1, 1974, Paper 74-160*. 10 p. Members, \$1.50; nonmembers, \$2.00. Grant No. NGR-33-016-131.

The problem is analyzed for the case of hydrogen fuel, taking into account supersonic and hypersonic vehicles using scramjet engines. The combustion in scramjets occurs at very high velocity and in a short time. In scramjet combustor designs, two different criteria can be used to design the engine. The amount of NO formed in the diffusion flame depends substantially on the maximum temperature reached. Effects of changing the mode of combustion from a diffusion flame to a heat conduction flame are considered, giving attention to the amount of NO produced in an engine of a given design. G.R.

A73-17631* # Key technology for airbreathing hypersonic aircraft. A. L. Nagel and J. V. Becker (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 9th, Washington, D.C., Jan. 8-10, 1973, Paper 73-58*. 12 p. 9 refs. Members, \$1.50; nonmembers, \$2.00.

This paper reviews recent progress in the key hypersonic technologies, which has been good despite a relatively low priority. Successful hypersonic research engine tests have been made. Active cooling system analyses have shown potential for weight savings, alleviation of structural design problems, and long airframe life. Maturing computerized flow field theories permit optimizing engine-airframe performance. Adequate progress in the future requires an expanded technology program emphasizing hydrogen usage. A hydrogen fueled hypersonic research airplane is essential, providing critical flight data and operational experience. (Author)

Billings, R. E., and Lynch, F. E.,
"History of Hydrogen - Fueled
Internal Combustion Engines", publica-
tion 73001, Energy Research Co.,
Provo, Utah, 1973.

LIQUID HYDROGEN STUDIED FOR TRANSPORTS.

E.J. Bulban.
A.W.&S.T., Nov. 5, 1973, p. 27-28.

A74-17905 # The hydrogen fuel economy and aircraft propulsion. A. L. Austin (California, University, Livermore, Calif.) and R. F. Sawyer (California, University, Berkeley, Calif.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Conference, 9th, Las Vegas, Nev., Nov. 5-7, 1973, AIAA Paper 73-1319*. 6 p. 20 refs. Members, \$1.50; nonmembers, \$2.00. Grant No. AF-AFOSR-72-2299.

Considerable interest has been directed toward the use of hydrogen as an ultimate replacement for fossil fuels. It is clean burning at comparable thermal efficiencies in piston and turbine engines, exists as a huge resource, and since the primary combustion product is water, the cycle from ecosystem to use and back to ecosystem is probably measured in years rather than millions of years as is the case with fossil fuels via the carbon cycle. The other fundamental advantage is that energy storage per unit weight is less than fossil fuels, and therefore hydrogen is an attractive fuel for aircraft. Large new sources of hydrogen at a low price are required before hydrogen can play an important role as an aircraft fuel. F.R.L.

A74-11315 # The case for hydrogen fueled transport aircraft. G. D. Brewer (Lockheed-California Co., Burbank, Calif.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Conference, 9th, Las Vegas, Nev., Nov. 5-7, 1973, AIAA Paper 73-1323*. 13 p. 14 refs. Members, \$1.50; nonmembers, \$2.00.

Arguments in favor of the substitution of liquid hydrogen for oil to power commercial aircraft are presented. Shortage of petroleum in the United States and the need for import will lead to unacceptable dependence on foreign nations, will cost the U.S. heavily in terms of deficit balance of payments, and can become a continuous threat of interruption of oil supply that will endanger our independence in the fields of commerce, world trade, diplomacy, and even our national security. In addition, hydrogen offers potential advantages when used in aircraft. Examples of subsonic and supersonic commercial aircraft are examined to determine the advantages in performance, pollution, noise, and cost. Some problems associated with the use of liquid hydrogen as a fuel are discussed. V.P.

FUEL SHORTAGES SPUR HYDROGEN INTEREST.

C. Covault.

Avia. Wk. & Space Tech., Dec. 17, 1973, p. 38-42.

NASA is considering modification of two Lockheed C-141 jet transports into hydrogen-powered test-beds as one of a number of steps to find an alternate to fossil-based fuels. Lockheed has been selected by LaRC to study application of LH₂ fuel to subsonic aircraft.

N74-11743* Old Dominion Univ., Norfolk, Va. Dept. of Mechanical Engineering.

THE ENERGY DILEMMA AND ITS IMPACT ON AIR TRANSPORTATION

Calvin R. Dyer, ed., Michael Z. Sirovoff, ed., and Paul D. Critchins, ed. 1973 171 p refs

(Grant NGT-47-003-028)

(NASA-CR-135993) Avail: NTIS HC \$10.75 CSCI 05A

The dimensions of the energy situation are discussed in relation to air travel. Energy conservation, fuel consumption, and combustion efficiency are examined, as well as the proposal for subsonic aircraft using hydrogen fuel. For individual titles, see N74-11744 through N74-11748.

N74-11744* Old Dominion Univ., Norfolk, Va.

THE ENERGY SITUATION

In its The Energy Dilemma and Its Impact on Air Transportation 1973 p 1-48 refs (For availability see N74-11743 02-34)

CSCI 05A

Energy reserves from the principal energy sources other than petroleum and natural gas are summarized. It was found that energy sources are being consumed at rates which exceed the ability to replace them through new discoveries and technology improvements. The costs and implications to environment for using coal and nuclear energy are discussed. Tables are presented on energy consumption, cost of reclamation, and water power capacity. J.A.M.

N74-11745* Old Dominion Univ., Norfolk, Va.

THE AIR TRANSPORTATION/ENERGY SYSTEM

In its The Energy Dilemma and Its Impact on Air Transportation 1973 p 49-70 refs (For availability see N74-11743 02-34)

CSCI 05A

The changing pattern of transportation is discussed, and the energy intensiveness of various modes of transportation is also analyzed. Sociopsychological data affecting why people travel by air are presented, along with governmental regulation and air transportation economics. The aviation user tax structure is shown in tabular form. J.A.M.

N74-11746* Old Dominion Univ., Norfolk, Va.

ENERGY CONSERVATION AND AIR TRANSPORTATION
In its The Energy Dilemma and Its Impact on Air Transportation 1973 p 71-84 refs (For availability see N74-11743 02-34)

CSCI 05A

Air transportation demand and passenger energy demand are discussed, in relation to energy conservation. Alternatives to air travel are reviewed, along with airline advertising and ticket pricing. Cargo energy demand and airline systems efficiency are also examined, as well as fuel conservation techniques. Maximum efficiency of passenger aircraft, from B-747 to V/STOL to British Concorde, is compared. J.A.M.

N74-11747* Old Dominion Univ., Norfolk, Va.

AN INITIAL STEP: A DEMONSTRATION PROJECT

In its The Energy Dilemma and Its Impact on Air Transportation 1973 p 95-117 refs (For availability see N74-11743 02-34)

CSCI 05A

To initiate the transition into a clean and diverse energy environment independent of fossil-based fuels, the rapid development of a subsonic, hydrogen-fueled aircraft is recommended. Tables are presented on characteristics of synthetic fuels, comparisons with JP-4 and gasoline, comparison of nitric oxide emissions from hydrocarbon and hydrogen fuels vs. fuel flame temperature, and sensitivity limits of LH2 detectors. J.A.M.

N74-11748* Old Dominion Univ., Norfolk, Va.

CONCLUSIONS AND RECOMMENDATIONS

In its The Energy Dilemma and Its Impact on Air Transportation 1973 p 119-173 refs (For availability see N74-11743 02-34)

CSCI 05A

Conclusions and recommendations are presented for an analysis of the total energy situation; the effect of the energy problem on air transportation; and hydrogen fuel for aircraft. Properties and production costs of fuels, future prediction for energy and transportation, and economic aspects of hydrogen production are appended. J.A.M.

CN-140, 323

PARTIAL HYDROGEN INJECTION INTO INTERNAL COMBUSTION
ENGINES EFFECT ON EMISSIONS AND FUEL ECONOMY.
R. Breshears, H. Cottrill and J. Rupe, JPL. (Presented
at EPA, The First Symp. on Low Pollution Power
Systems Development. Held at Ann Arbor, Michigan,
Oct. 14-19, 1973). 28p.

Jet Propulsion Lab., Calif.
Inst. of Tech.

Environmental Protection Agency
Symposium on Low Pollution Power Systems
Development, 1st

Oct. 14-19,
1972

Engines, Internal combustion
Engines, Automobile
Engine emission
Fuel consumption

L-2-21-74

→ Hydrogen

CN-140, 370

THE ECONOMICS OF LIQUID HYDROGEN SUPPLY FOR AIR
TRANSPORTATION. John E. Johnson. (Presented at the
Cryogenic Engineering Conference, Atlanta, Ga.,
Aug. 10, 1973). 12p.

Union Carbide Corp.
Cryogenic Engineering Conference

Aug. 10,
1973

Hydrogen, Liquid
Economics
Air transportation

L-3-4-74

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.155
1973

Intersociety Energy Conversion Engineering Con-
ference, 8th Philadelphia, Pa., 1973.
Proceedings. New York, American Institute of
Aeronautics and Astronautics [1973]
847 p. illus. 29 cm.

Held at: University of Pennsylvania, Philadel-
phia, Pa., August 13-16, 1973.

Sponsored by: American Institute of Aero-
nautics and Astronautics [and others]

The Hydrogen-Air Fueled Automobile Engine (Part I) - R. R. ADT, JR.,
D. L. HERSHBERGER, T. KARTAGE, M. R. SWAIN.....P. 194-...

CN-140, 369

N74-15449# Oak Ridge National Lab. Tenn.
PROSPECTS FOR HYDROGEN AS A FUEL FOR TRANSPOR-
TATION SYSTEMS AND FOR ELECTRICAL POWER
GENERATION

W. J. D. Escher. Sep. 1973 56 p refs
(Contract W-7405-eng-26)
(ORNL-TM-4305) Avail: NTIS HC \$5.00

The potential application of hydrogen, produced from
non-fossil domestic sources, is examined for applicability to the
transportation and electrical generation sectors. The characteristics
of hydrogen as a gas and as a cryogenic liquid are noted; cost
trends are presented. Ground, water, and air transportation modes
and systems are individually examined with respect to a
potential conversion to hydrogen fuel. Electrical generation
systems, both conventional and unconventional, are assessed
similarly. Hydrogen's potential for transmission and storage of
electrical energy is cited. From these findings, a detailed list of
recommended study, research and development, and demonstra-
tion system topics is given toward implementing an eventual
conversion of transportation and the electrical utilities to hydrogen
fuel.

Author (NSA)

N74-19391# Michigan Univ., Ann Arbor. Dept. of Physics.
LIQUID HYDROGEN AS A FUEL FOR MOTOR VEHICLES:
A COMPARISON WITH OTHER SYSTEMS
Lawrence W. Jones [1973] 4 p
Avail: NTIS HC \$4.00

The pros and cons are explored of liquid hydrogen fuel,
especially for smaller systems (automobiles and trucks). The
alternative methods of liquid hydrogen fueling, whether by
replaceable tanks or pumping from a storage vessel, are also
discussed.

Author

1973

N73-24777*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
THE USE OF HYDROGEN FOR AIRCRAFT PROPULSION IN VIEW OF THE FUEL CRISIS *ALSO A73-35469#*
 Solomon Weiss 1973 38 p. refs. Presented at NASA Res. and Technol. Advisory Comm. on Aeronaut. Operating Systems, Moffett Field, Calif., 7-8 Mar. 1973
 (NASA-TM-X-68242; E-7490) Avail: NTIS HC \$4.00 CSCL 21D

Some factors influencing the technical feasibility of operating a liquid hydrogen-fueled airplane are discussed in light of the projected decrease of fossil fuels. Other sources of energy, such as wind, tidal, solar, and geothermal, are briefly mentioned. In view of projected decreases in available petroleum fuels, interest has been generated in exploiting the potential of liquid hydrogen (LH2) as an aircraft fuel. Cost studies of LH2 production show it to be more expensive than presently used fuels. Regardless of cost considerations, LH2 is viewed as an attractive aircraft fuel because of the potential performance benefits it offers. Accompanying these benefits, however, are many new problems associated with aircraft design and operations; for example, problems related to fuel system design and the handling of LH2 during ground servicing. Some of the factors influencing LH2 fuel tank design, pumping, heat exchange, and flow regulation are discussed.

Author

1973

(LA-UR-73-715) LOGISTICS, ECONOMICS, AND
SAFETY OF A LIQUID HYDROGEN SYSTEM FOR AUTOMOTIVE TRANSPORTATION. Stewart, W. F.; Edeakuty, F. J. (Los Alamos Scientific Lab., N. Mex.). 1973. Contract W-7405-eng-36. 31p. (CONF-730917-1). Dep. NTIS \$3.75.

From intersociety conference on transportation; Denver, Colorado, USA (24 Sep 1973).

A hydrogen-powered automobile plays a prominent role in many of the proposed solutions for the energy crisis. The development of a hydrogen powered automobile involves the development of a hydrogen-fueled engine, a hydrogen storage system on-board the vehicle, and a hydrogen production and distribution system. Several design aspects, cost estimates, and safety considerations are discussed for a liquid hydrogen production and distribution system. The amount of liquid hydrogen that must be produced annually to replace the gasoline consumed by automobiles is estimated. This estimate includes boiloff, cooldown, and transfer losses from the production plants, transport trailers, service stations, and automobiles. (7 tables, 4 figures, 40 references) (auth)

346

1973

A73-38373*# Energy supply and its effect on aircraft of the future. II - Liquid-hydrogen-fueled aircraft: Prospects and design issues. F. S. Kirthem and C. Driver (NASA, Langley Research Center, Hampton, Va.). American Institute of Aeronautics and Astronautics, Aircraft Design, Flight Test and Operations Meeting, 5th, St. Louis, Mo., Aug. 6-8, 1973, Paper 73-809. 11 p. 10 refs. Members, \$1.50; nonmembers, \$2.00.

The performance of hydrogen-fueled commercial aircraft is examined in the subsonic, supersonic, and hypersonic speed regime and compared with JP-fueled systems. Hydrogen aircraft are shown to provide substantial improvements in range and payload fraction as well as to minimize or eliminate many environmental problems. The major elements of a development program required to make hydrogen-fueled aircraft a commercial reality are also outlined and the rationale for and characteristics of both a subsonic demonstrator and a high speed research airplane are described. (Author)

1973

THE AUTOCGENOUS HYDROGEN AUTOMOBILE.

R.D. Williams & G.A. Lorton.

J. Environmental Systems, v.3, no.4, Winter 1973, p.267-275.

The first phase of a feasibility study for the incorporation of catalytic steam reforming reactors into mobile power plant fuel systems has been completed. Two laboratory prototype reformers were used to steam reform hexane feedstock to fuel gas mixtures consisting of H₂, CH₄, CO, and CO₂. Above 485°C conversion was found to be equilibrium (rather than kinetically) controlled by the methane reforming and water gas shift reactions. Reactors used were 1) a 9" long section of 2" stainless steel pipe, and 2) a 5" long section of 3-1/4" stainless steel pipe. In both cases the reactors were filled with Girdler 5/8" rasching ring nickel reforming catalyst. Reactor residence times near .01 seconds allowed complete conversion of hexane to theoretically predicted equilibrium product distributions. Experimental hydrogen composition in the fuel gas generated at 2.5 atm with a steam to carbon ratio of 2.56 ranged from .38 to .68 mole per cent (dry basis) at temperatures of 485°C and 695°C respectively. The equivalent reactor volume required to provide fuel gas at a rate sufficient to power a medium sized car at 60 mph is estimated to be on the order of 0.2 cubic feet. Additional size reduction may be realized with more active reforming catalysts especially considering that operation was not found to be kinetically controlled.

N74-20647 Escher Technology Associates, St. Johns, Mich.
PROSPECTS FOR LIQUID HYDROGEN FUELED COM-
MERCIAL AIRCRAFT

William J. D. Escher Sep. 1973 39 p refs
(PR-37) Copyright. Avail: Issuing Activity

The use of hydrogen as a fuel for aircraft propulsion is discussed. The benefits of hydrogen with respect to air pollution reduction are analyzed. Liquid hydrogen as a potential future aviation fuel is considered to be the only practical chemical fuel producible from ultimate nonfossil energy primary sources. The aerodynamic configurations and aircraft systems involved in hydrogen propulsion are described and illustrated. The facilities and processes for commercial production of hydrogen are reported.

Author

N74-18403# Stevens Inst. of Tech., Hoboken, N.J.
THE HYDROGEN IC ENGINE: ITS ORIGINS AND FUTURE
IN THE EMERGING ENERGY TRANSPORTATION-
ENVIRONMENT SYSTEM

Kurt H. Weil [1973] 9 p refs
(Rept-729212) Avail: NTS HC \$4.00

A historical review of the internal combustion engine is presented. The use of hydrogen based fuels instead of hydrocarbon fuels are discussed as a fuel source for controlling air pollution both in automobiles and in electric utilities.

S.K.W.

THE HYDROGEN CAR.

(JPL's & NASA's partly-powered hydrogen car.)

New Scientist, 12 Oct. 1973,
pp 202-203

TK
2896 Intersociety Energy Conversion Engineering
I 55 Conference, 7th, San Diego, Calif., 1972.
1972 Proceedings. Washington, D. C., American
Chemical Society, 1972.
1533 p. illus. 28 cm.

Potentials and Problems of Hydrogen Fueled Supersonic and Hypersonic Aircraft
R. D. Witcofski p. 1349-

The Boston Reformed Fuel Car-A Low Polluting Gasoline Fuel System for
Internal Combustion Engines, H. Sorenson p. 1328-

PROSPECTS FOR HYDROGEN-FUELED VEHICLES.

R.J. Schoeppel.
Chemtech, Aug.1972, p.476-480.

Primarily concerned with the use of hydrogen in ground vehicles, although it is obvious that hydrogen can be substituted for any other fuel now in use.

THE AIRCRAFT RUNS ON HYDROGEN.

New Scientist, Nov.16,1973, p482.

Gulf General Atomic has a research program to apply nuclear energy to the task of generating hydrogen from water.

MORE STRESS ON HYDROGEN ENGINES.

Technology Forecast, Oct.1973, p.9,10.

1972

HYDROGEN ENGINE IN PERSPECTIVE. Murray, R. G. (Oklahoma State Univ., Stillwater); Schoepel, R. J.; Gray, C. L. pp 1375-1381 of 7th Intersociety Energy Conversion Engineering Conference. Washington, DC; American Chemical Society (1972). **TK 2896, I 55 1972**

From 7th Intersociety energy conversion engineering conference; San Diego, California, USA (25 Sep 1972). See CONF-720925-

The latest performance and emission characteristics of the Oklahoma State University air breathing, hydrogen-burning engine are reported. The engine is put in perspective in the future total energy picture. Four years ago development started on the first of a series of hydrogen-fueled engines at Oklahoma State University. Early data indicated that a hydrogen-fueled engine should yield torque, power, and efficiency values comparable to an equivalent spark ignition engine. The performance outlook of this first engine was so optimistic that the Air Pollution Control Office, Environmental Protection Agency funded an effort to study further design improvements and to test its emission characteristics.

Recent tests indicate that it should be possible to fabricate a reliable engine to power an automobile or truck. It is expected that this vehicle would have adequate range, normal size, and would fall within a complexity and reliability range similar to today's gasoline counterpart. It would emit no measurable hydrocarbons, organic, or sulfur compounds. Oxides of nitrogen emission below 1976 standards would be expected. (auth)

1972

TK 2896, I 55 1972

LIQUID HYDROGEN AS A FUEL FOR MOTOR VEHICLES: A COMPARISON WITH OTHER SYSTEMS. Jones, L. W. (Univ. of Michigan, Ann Arbor). pp 1384-1385 of 7th Intersociety Energy Conversion Engineering Conference. Washington, DC; American Chemical Society (1972).

From 7th Intersociety energy conversion engineering conference; San Diego, California, USA (25 Sep 1972). See CONF-720925-

Hydrogen as a liquid has obvious advantages as a fuel: relatively high density, use of low-pressure containers, and aesthetic simplicity. On the other hand, the complications of cryogenics handling, boiloff losses, and intrinsic thermodynamic inefficiencies make the virtues of liquid hydrogen not without attendant liabilities. The advantages and disadvantages of the liquid fuel, especially for smaller systems (automobiles and trucks), are explored. The alternative methods of liquid-hydrogen fueling, whether by replaceable tanks or pumping from a storage vessel, are also discussed. (auth)

1972

TK 2896, I 55 1972

HYDROGEN IC ENGINE: ITS ORIGINS AND FUTURE IN THE EMERGING ENERGY-TRANSPORTATION-ENVIRONMENT SYSTEM. Well, K. H. (Stevens Inst. of Tech., Hoboken, NJ). pp 1365-1363 of 7th Intersociety Energy Conversion Engineering Conference. Washington, DC; American Chemical Society (1972).

From 7th Intersociety energy conversion engineering conference; San Diego, California, USA (25 Sep 1972). See CONF-720925-

It is not the internal combustion engine that pollutes the air, but its present fuels. Lower-efficiency-cycle automotive engines and catalytic exhaust treatment are technically unsound and waste remaining hydrocarbon reserves. The hydrogen internal combustion engine's multi-fuel version is the key component of the evolving comprehensive electricity-hydrogen energy system, controlling air pollution and the electric utilities' predicament with low load factors, transmission, and energy storage. Any pragmatic transition rate in time and regional geography may be programmed with this engine—not excluding other promising approaches. To make sound decisions, in time, about realistic compromises based on facts, preparations should begin now. (29 references) (auth)

1972

TK 2896, I 55 1972

HIGHER-ENERGY FORM OF WATER (H₂O*) IN AUTOMOTIVE VEHICLE-ADVANCED POWER SYSTEMS. Escher, W. J. D. (Escher Tech. Associates, St. Johns, MI). pp 1392-1402 of 7th Intersociety Energy Conversion Engineering Conference. Washington, DC; American Chemical Society (1972).

From 7th Intersociety energy conversion engineering conference; San Diego, California, USA (25 Sep 1972). See CONF-720925-

The hydrogen-oxygen (stoichiometric) bi-reactant combination, separately tanked and fed to an advanced-design automotive power plant is addressed. This "higher energy form" of water is compared in terms of: onboard vehicle stored energy, volume, mass

and cost with conventional systems employing gasoline- and hydrogen-fueled internal combustion engines. The higher energy form of water, H₂O*, will be produced in abundance in future water-splitting hydrogen production facilities using nuclear or solar energy as being envisioned for the post fossil-fuel age "Hydrogen Economy." However, the majority of hydrogen energy conversion system studies so far have addressed hydrogen's reaction with air, not oxygen. If high-temperature H₂O*-fueled power cycles (3000 to 4000°F) can be developed, a savings in national energy resources of the order of 60% of that needed for present gasoline-fueled automobiles and future hydrogen-fueled vehicles is technically possible. The sole effluent in H₂O* combustion is the lower energy form of water. (MCW)

348

TK 2896, I55 1972

ECONOMICS OF HYDROGEN FUEL FOR TRANSPORTATION AND OTHER RESIDENTIAL APPLICATIONS. Wilschke, W. E.; Hoffman, K. C.; Salzano, F. J. (Brookhaven National Lab., Upton, NY). pp 1368-1374 of 7th Intersociety Energy Conversion Engineering Conference. Washington, DC; American Chemical Society (1972).

From 7th intersociety energy conversion engineering conference; San Diego, California, USA (25 Sep 1972). See CONF-720925-

In order to examine the potential role of hydrogen in the nation's energy economy, this paper focuses on the economics of hydrogen delivered to the domestic consumer, the current state of the technology, and the research and development required to implement hydrogen production and delivery systems. Application of hydrogen fuel in domestic energy systems includes the automobile, space heating, cooking, refrigeration, and electrical generation. A comparison is made between several representative energy delivery systems using hydrogen and conventional energy systems using electricity and gasoline. Quantitative information is given on the environmental advantages of hydrogen that make it an attractive and flexible secondary source of energy. The current state of the art is discussed and suggests some areas of technology to be advanced before implementation of hydrogen as a universal fuel. (20 references) (MCW)

1972

TK 2896, I55 1972

METAL HYDRIDES FOR ENERGY STORAGE. Wiswall, R. H. Jr.; Reilly, J. J. (Brookhaven National Lab., Upton, NY). pp 1342-1348 of 7th Intersociety Energy Conversion Engineering Conference. Washington, DC; American Chemical Society (1972).

From 7th intersociety energy conversion engineering conference; San Diego, California, USA (25 Sep 1972). See CONF-720925-

The use of metal hydrides as hydrogen reservoirs facilitates the storage and subdivision of central-station power for automotive and other purposes. Hydrides with a wide range of properties have been synthesized and studied, and several appear to have promise for specific storage applications. Results are reported on the effect of alloy constituents on hydride stability; on the formation of hydrides by metals reacting with gas mixtures such as those produced by the steam reforming of hydrocarbons; and on the feasibility of integrated systems of hydride reservoir plus engine or fuel cell. (auth)

N73-16766# California Univ., Livermore. Lawrence Livermore Lab.

SURVEY OF HYDROGEN'S POTENTIAL AS A VEHICULAR FUEL

A. L. Austin. 19 Jun. 1972. 35 p refs (Contract W-7405-Eng-48) (UCRL-51228) Avail: NTIS

The problems and potential of various hydrogen-based mobile fuel systems and the likely economic impact of a nationwide conversion to hydrogen are examined. The basic technical problem is to store enough hydrogen per vehicle in a small enough volume. The prospects of using gaseous and liquid hydrogen with air, liquid hydrogen with liquid oxygen, and hydrogen stored in metal hydrides in an internal combustion engine are analyzed. The practical feasibility is found to be marginal but with enough potential to justify an ongoing research program. Author

1972

TK 2896, I55 1972

HYDROGEN-AIR FUELED AUTOMOBILE. Swain, M. R.; Ait, R. R. Jr. (Univ. of Miami, Coral Gables, FL). pp 1382-1387 of 7th Intersociety Energy Conversion Engineering Conference. Washington, DC; American Chemical Society (1972).

From 7th intersociety energy conversion engineering conference; San Diego, California, USA (25 Sep 1972). See CONF-720925-

The research and development effort required to convert a 1970 Toyota 1600 station wagon to run on a hydrogen-air fuel mixture is described. The unique engine design modifications involve only minor changes to the Otto cycle engine and will not require extensive manufacturer's retooling. In addition a high pressure source of hydrogen is not needed. Total engine cost is expected to be less than that of a similar gasoline fueled low emission engine. An approximately 50% increase in efficiency over that of the gasoline fueled engine is realized. Nitric oxide emissions, the only exhaust gas constituents of concern, are expected to meet the 1975 emission standards. The 1976 and later standards are expected to be met with minor modifications. (auth)

SAE J. Automotive Engineering, v.80, no.11, Nov.1972.

H-O fuel system raises engine thermal efficiency
Computer study shows feasibility of hydrogen-oxygen spark-ignition engine with exhaust gas recycling.
Further study of the engine appears important, especially in reducing air pollution.

N73-22711*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
PRELIMINARY APPRAISAL OF HYDROGEN AND METHANE FUEL IN A MACH 2.7 SUPERSONIC TRANSPORT
 John B. Whitlow, Jr., Richard J. Weber, and Kestutis C. Cvirskas
 [1972] 51 p refs Prepared in cooperation with Army Air Mobility R and D Lab, Cleveland
 (NASA-TM-X-68222; E-7425) Avail: NTIS HC \$4.75 CSCL 21D

The higher heating value of hydrogen relative to JP fuel is estimated to reduce fuel weight by three fold and gross weight by 40 percent for comparable designed airplanes of equal payload and range. Engine design parameters were varied to determine the influence of lower noise goals on gross weight and direct operating cost. At current fuel prices, the DOC of a hydrogen airplane would be much higher than that of a JP airplane. A methane airplane could offer an 8.5-percent lower KOC than JP. But future shortages may escalate the prices of both JP and methane, whereas the price of hydrogen manufactured hydrolytically could be reduced from present levels. If in the future all three fuels are postulated to have equal costs per unit of energy, the DOC for hydrogen could be as much as 20 percent below that for JP on the reference 4000-nautical-mile mission. Longer ranges or lower noise requirements would improve the advantage of hydrogen.
 Author

N73-11019*# LTV Aerospace Corp., Hampton, Va. Hampton Technical Center.
A FUEL CONSERVATION STUDY FOR TRANSPORT AIRCRAFT UTILIZING ADVANCED TECHNOLOGY AND HYDROGEN FUEL
 W. Berry, R. Calleson, J. Espil, C. Quarero, and E. Swanson
 10 Nov. 1972 33 p refs
 (Contract NAS1-10900)
 (NASA-CR-112204) Avail: NTIS HC \$3.75 CSCL 01B

The conservation of fossil fuels in commercial aviation was investigated. Four categories of aircraft were selected for weight: (1) conventional, medium range, low take-off gross weight; (2) conventional, long range, high take-off gross weight; (3) large take-off gross weight aircraft that might find future applications using both conventional and advanced technology; and (4) advanced technology aircraft of the future powered with liquid hydrogen fuel. It is concluded that the hydrogen fueled aircraft can perform at reduced size and gross weight the same payload/range mission as conventionally fueled aircraft. F.O.S.

N72-32742*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.
ECONOMIC STUDY OF FUTURE AIRCRAFT FUELS (1970-2000)

Arthur D. Alexander, III Sep. 1972 30 p refs
 (NASA-TM-X-62180) Avail: NTIS HC \$3.50 CSCL 21D
 Future aircraft fuels are evaluated in terms of fuel resource availability and pricing, processing methods, and economic projections over the period 1970-2000. Liquefied hydrogen, methane and propane are examined as potential turbine engine aircraft fuels relative to current JP fuel.
 Author

HYDROGEN FUELED HYPERSONIC TRANSPORTS.

R.D. Witcofski.

Presented at the Amer. Chem. Soc. Symposium
 on Non-Fossil Chemical Fuels, Boston, Mass.,
 Apr. 9-14, 1972.

N72-23842# Oklahoma State Univ., Stillwater. School of Mechanical and Aerospace Engineering.
DESIGN CRITERIA FOR HYDROGEN BURNING ENGINES
 Final Report. 1 Jun. 1970 - 30 Sep. 1971
 Roger J. Schoepel Oct. 1971 157 p refs
 (Contract EPA-EHSH-70-103)
 (PB-205815; APTD-0901) Avail: NTIS HC \$4.75 CSCL 21B

Laboratory experiments have demonstrated hydrogen not only to be an excellent substitute for conventional hydrocarbon fuels in internal combustion engines but also to have the inherent qualities necessary for a permanent solution to the air pollution problem. This conclusion was reached after extensive tests were conducted with an aircooled single-cylinder gasoline engine converted to run on hydrogen. The engine's operational characteristics compared favorably with those of its gasoline counterpart. Furthermore, the NOX content of the exhaust was an order of magnitude lower than that expected from a gasoline engine. Trace amounts of unburned hydrocarbons and carbon oxides, also present, originated from the lubricating oil. It was concluded from these experiments that a multi-cylinder automotive engine converted to run on hydrogen should be able to meet the 1975/76 Federal Emission Standards.
 Author (GRA)

TK2896. I55 1971

R. G. Murray and R. J. Schoepfel,
"Emission and Performance Characteristics
of an Air-Breathing Hydrogen-Fueled Internal
Combustion Engine." Paper 719009 presented
at the 1971 Intersociety Energy Conversion
Engineering Conference, Boston, August 1971.

TK2896. I55 1971

P. Underwood and P. Dieges, "Hydrogen
and Oxygen Combustion for Pollution Free Opera-
tion of Existing Standard Engines," Intersociety
Energy Conversion Engineering Conference Pro-
ceedings, Society of Automotive Engineers, p.317
1971.

N72-12995*# National Aeronautics and Space Administration,
Langley Research Center, Langley Station, Va.
VEHICLE TECHNOLOGY FOR CIVIL AVIATION: THE
SEVENTIES AND BEYOND Conference Proceedings
Washington 1971 452 p refs Conf. held at Langley Sta., Va.,
2-4 Nov. 1971

(NASA-SP-292) Avail: NTIS HC \$6.00/MF \$0.95 CSCL 01C
Technological concepts for the development of future
advanced transport aircraft in civil aviation are developed.
Highlighted are promising avenues of research that offer the
potential of improving both current and future civil aircraft in the
fields of aerodynamics, propulsion, structures and materials,
operational aspects, and technology application. For individual
titles, see N72-12996 through N72-13020.

N71-21634# Ohio State Univ. Research Foundation, Columbus.
SUPERSONIC COMBUSTION AND BURNING IN RAMJET
COMBUSTORS Final Report, 1 Feb. 1966 - 31 Mar. 1970

Rudolph Edse Jun. 1970 205 p refs

(Grant AF-AFOSR-0203-67)

(AD-716855: OSURF-2153-3: AFOSR-70-2467TR) Avail: NTIS
CSCL 21/2

Induction distances, transient pressures, and wave propagation
rates were determined in cylindrical tubes for detonation waves in
stoichiometric hydrogen-oxygen mixtures initially at one atmosphere
and temperatures ranging from 300K down to 123K. The
induction distances became considerably shorter as the initial gas
temperature was decreased. At temperatures from 500 to 123K the
normal burning speed of stoichiometric hydrogen-oxygen mixtures
was found to be proportional to the absolute temperature of the
unburnt gas. High-strength shock waves were fired into lean
hydrogen-oxygen mixtures to study the propagation rates of the
flames behind these waves (overdriven detonations). Ignition delay
times in hydrogen-nitric oxide mixtures were found to be very long.
Stable detonation waves could not be produced in these mixtures.
Quantum yields and induction times have been measured in flowing
mixtures of hydrogen, oxygen, and chlorine to determine the
feasibility of photochemically initiated supersonic combustion.
Expressions have been derived to predict the induction times and
quantum yields. A method has been developed for calculating the
state of the gas behind a normal shock in a shock tube for the
case that both the driver and the driven gas undergo chemical
changes during the process. Results indicate that for dissociating
hydrogen calculations based on the use of certain values of the
specific heat ratio may be in error by 30% for the calculated
particle speed.

Author (GRA)

A70-44127 * # New approaches to hypersonic aircraft. John V. Becker (NASA, Langley Research Center, Aero-Physics Div., Hampton, Va.). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-16*, 28 p. 31 refs.

The strong interactions between the aerodynamic, structural, and propulsive systems of hypersonic air breathers offer important opportunities for achieving improved vehicles. One of the most promising is the use of the hydrogen fuel heat sink to provide cooling of major areas of the airframe. This possibility is explored in some detail, with considerations of the theoretical possibilities, engine designs for minimum cooling, comparative analysis of candidate high-level cooling systems, recent fluid-mechanical studies of slot cooling, structural designs compatible with practical cooling systems, and aerodynamic features made possible in actively cooled vehicles. The results suggest that hypersonic cruise vehicles constructed of largely unshielded aluminum or titanium alloys are feasible and offer a number of advantages. Further studies of the problems and possibilities of this category of hypersonic vehicles are suggested.

(Author)

Murray, R. G., and Schoepfel, R. J., A Reliable Solution to the Environmental Problem: The Hydrogen Engine, *Pap. 700609*, presented at SAE/AIAA/ASME Reliability and Maintainability Conference, Detroit, Mich., July 20-22, 1970.

K. C. Hoffman et al., "Metal Hydrides as a Source of Fuel for Vehicular Propulsion," SAE International Auto Engineering Conference, Detroit, Mich., Jan. 13-17, 1969.

Schoepfel, R. J., and Murray, R. G., The Development of Hydrogen Burning Engines, *Proceedings, Frontiers of Power Technology Conference, Oklahoma State University, Stillwater, Okla., 1968*, p. 12.

A70-31851 * # Hypersonic aircraft technology and applications. A. J. Eggers, Jr., N. B. Cohen (NASA, Washington, D.C.), and R. H. Petersen (NASA, Ames Research Center, Moffett Field, Calif.). *Astronautics and Aeronautics*, vol. 8, June 1970, p. 30-41. 31 refs.

Discussion of hypersonic aircraft technology giving particular attention to a long-range transport and to a reusable launch vehicle. The study of hypersonic commercial transports indicates that hypersonic aircraft cruising at about Mach 6 can carry large payloads over long ranges. The advantages of liquid hydrogen as a fuel are pointed out. The effect of size on hypersonic-transport payload is investigated. An airbreathing booster and rocket-powered orbiter stage at Mach 10, in an artist's concept of a shuttle operation is shown. Propulsion system technology is considered. For Mach numbers above about 8, the scramjet offers the most promising approach.

G.K.

Schoepfel, R. J., and Sadiq, S., The Role of the Power Industry in Supporting the Hydrogen Engine and Clean Air, *Proceedings, Frontiers of Power Technology Conference, Stillwater, Okla., October 15-16, 1970*.

LIQUID HYDROGEN ENGINES.

R. C. Mulready.

Chapt.5 in: Technology and Uses of Liquid
Hydrogen, Scott, R.B., ed.,
Pergamon Press, Elmsford, N.Y.,
1964, p.149-180.

69N80675 AD-642256 61/00/00 265 PAGES UNCLASSIFIED DOCUMENT
ADVANCED PROPULSION TECHNIQUES
A/PENNER, S. S. (AED.)
ADVISORY GROUP FOR AERONAUTICAL RESEARCH AND DEVELOPMENT, PARIS
(FRANCE).
PROC. OF A TECH. MEETING SPONSORED BY THE AGARD COMBUST. AND
PROPULSION PANEL, PASADENA, CALIF., 24-26 AUG. 1960
/♦CHEMICAL REACTORS/♦ELECTRIC PROPULSION/♦NUCLEAR PROPULSION/♦SOLAR
GENERATORS/ BIBLIOGRAPHIES/ ELECTRIC POWER/ HEAT TRANSFER/ HYDROGEN/
RAMJET ENGINES/ TURBOJET ENGINES

66N80553♦ NASA-TM-X-57052 58/00/00 28 PAGES UNCLASSIFIED DOCUMENT
THEORETICAL EVALUATION OF THE PERFORMANCE OF AIR-BREATHING HYPERSONIC
AIRPLANES
A/BALDWIN, B. S., JR.
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. AMES RESEARCH CENTER,
MOFFETT FIELD, CALIF.
<1958> 28 P PRESENTED AT THE 3D SYMP. ON HIGH-SPEED AERODYN. AND
STRUC. SAN DIEGO, CALIF., 25-27 MAR. 1958
/ AIR/ AIRCRAFT/ BREATHING/ BURNOUT/ FUEL/ HYDROGEN/ HYPERSONIC/
PERFORMANCE/ RAMJET/ ROCKET/ VANGUARD PROJECT/ VELOCITY

71N74766♦ NASA-MEMO-11-29-58E 58/11/00 23 PAGES UNCLASSIFIED
DOCUMENT
PERFORMANCE OF HYDROGEN FUELED COMBUSTORS FOR A MACH 4 TURBOJET
ENGINE
A/JONES, R. E.; B/PAWLIK, E. V.
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. LEWIS RESEARCH CENTER,
CLEVELAND, OHIO.
WASHINGTON
/♦AIRCRAFT FUELS/♦HYDROGEN/♦TURBOJET ENGINES/ COMBUSTION CHAMBERS/
PERFORMANCE TESTS/ PROPULSION SYSTEM PERFORMANCE

PRELIMINARY ANALYSIS OF HYDROGEN-RICH
HYPERSONIC RAMJET OPERATION. (U). Roland
Reitwieser and James F. Morris. Jan. 14,
1958. 24p. diagrs.

Authors (2)

Net thrust, fuel flow, and related performance indices were calculated for hydrogen-rich operation of nacelle-type and submerged ramjet engines at Mach numbers from 5 to 20. Hydrogen-air ratios considered were high enough to limit the combustor temperature to a maximum of 2000°K. This propulsion method can produce fuel specific impulses considerably greater than those of rockets if impulses are averaged over the above range of flight speeds.

**MAJOR AN INVESTIGATION
OF THE EFFECTS OF TURBULENCE ON THE
FUEL-SYSTEM OPERATION WITH HYDROGEN FUEL
AT 400° F. (U). David M. Strehg,
Arthur L. Smith and Harold H. Christensen.
Mar. 7, 1957. 44p. diagrs., photos., tabs.**

NACA RM E57C29

INVESTIGATION OF AN AFTERBURNING RAMJET
USING GASEOUS HYDROGEN AS FUEL AT MACH
NUMBER OF 3.0. (U). Joseph F. Wasserbauer.
June 17, 1957. 11p. diagrs., photo.

Author

An experimental investigation was conducted in the Lewis 10- by 10-foot supersonic wind tunnel on a 16-inch ramjet that was equipped with an afterburner and used gaseous hydrogen for both the primary and afterburner fuels. The primary nozzle had a contraction ratio of 0.6 while the exit nozzle had a contraction ratio of 0.9. Data were obtained at a free-stream Mach number of 3.0 and zero angle of attack. The results of this investigation illustrate that at a constant diffuser-exit Mach number afterburner operation produces more than twice the thrust available without afterburning.

NACA RM E58C19a
EXPLORATORY INVESTIGATION OF PERFORMANCE OF
EXPERIMENTAL FUEL-RICH HYDROGEN COMBUSTION
SYSTEM. (U). Arthur L. Smith and Jack S.
Grobman. June 25, 1958. 42p. diagrs., photos.,
tabs.

Authors (2)

An exploratory investigation was conducted to determine the performance characteristics of a fuel-rich hydrogen combustor; in addition, the performance of an afterburner operating with the fuel-rich exhaust mixture was evaluated. Four experimental combustors with a burning length of 18 inches were operated over a range of equivalence ratios from 7 to 26 at nominal fuel flows of 100 and 200 pounds per hour, inlet-air temperature of 80° F., and inlet pressures near 30 inches of mercury absolute. Two

NACA RM E58A21a
COMBUSTION OF GASEOUS HYDROGEN AT LOW
PRESSURES IN A 35° SECTOR OF A 28-INCH-
DIAMETER RAMJET COMBUSTOR. (U). William
R. Kerslake. Apr. 22, 1958. 33p. diagrs., tabs.

Author

Gaseous hydrogen fuel was burned in a connected-pipe combustor with a cross section equal to 35° sector of a 28-inch diameter. Eleven shrouded fuel-injector configurations were used to obtain combustion data at the following high-altitude ramjet combustor conditions: pressure, 5 to 24 inches of mercury absolute; velocities, 340 to 160 feet per second; and inlet air temperature of 240° F. Combustion efficiencies were measured above 95 percent for wide bands of fuel air ratios. The combustor configurations reported herein extend the efficient burning range of hydrogen at ramjet conditions to a pressure of 1/6 atmosphere; best configurations previously reported gave high efficiency to only 1/3 atmosphere.

NACA RM E58D15a
COMBUSTION OF GASEOUS HYDROGEN IN A SMALL
RECTANGULAR RAMJET COMBUSTOR. (U). John
W. Sheldon. Aug. 25, 1958. 39p. diagrs., tabs.

Author

Seven fuel-injector-flameholder configurations were investigated in a rectangular ramjet combustor having a cross section of 1 by 6 inches. Combustion efficiencies were determined for a range of fuel-air equivalence ratios at the following combustor-inlet conditions: total pressure, 15 inches of mercury absolute; Mach number, 0.24; total temperature, 80° F. Combustor-inlet pressures resulting in blowout of the flame were also determined for a range of fuel-air equivalence ratios. For the combustor configurations and test conditions investigated, the maximum combustion efficiency obtained was 90 percent.

Afterburner flameholder configurations with a burning length of 36 inches were investigated over an equivalence-ratio range from 0.2 to 1 at inlet pressures near atmospheric.

NACA Rept. 1383

SURVEY OF HYDROGEN COMBUSTION PROPERTIES.
Isadore L. Drell and Frank E. Belles, LeRC.
1958. 34p. diagrs., tabs. (Supersedes
RM E57D24)

NACA RM E57D24
Authors (2)

This literature digest of hydrogen-air combustion fundamentals presents data on flame temperature, burning velocity, quenching distance, flammability limits, ignition energy, flame stability, detonation, spontaneous ignition, and explosion limits. The data are assessed, recommended values are given, and relations among various combustion properties are discussed. New material presented includes: theoretical treatment of variation in spontaneous-ignition lag with temperature, pressure, and composition, based on reaction kinetics of hydrogen oxidation; and calculated adiabatic flame temperatures over the entire hydrogen-air composition range for 0.01 to 100 atmospheres and initial temperatures of 0° to 1400° K.

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NACA RM E58A23

PERFORMANCE OF A 28-INCH RAMJET UTILIZING GASEOUS HYDROGEN AT A MACH NUMBER OF 3.6, ANGLES OF ATTACK UP TO 12°, AND PRESSURE ALTITUDES UP TO 110,000 FEET. (U). Norman T. Misal, James J. Ward and Joseph F. Wasserbauer. May 19, 1958. 24p. diagrs., photos.

Authors (3)

An investigation was conducted in the NACA Lewis 10-by 10-foot supersonic wind tunnel to evaluate the performance of a shrouded injector burner with perforated domes employed in a 28-inch ramjet using gaseous hydrogen as fuel. Steady-state data were obtained at a pressure altitude of 77,000 feet and zero angle of attack. Transient data were obtained at pressure altitudes up to 110,000 feet and angles of attack up to 12°. Results of this investigation showed that burning could be initiated under severe distortion conditions and that satisfactory combustor operation was accomplished up to a pressure altitude of 110,000 feet with no adverse effect on combustion efficiency.

NACA RM E58E20a

EXPLORATORY PERFORMANCE INVESTIGATION OF COMBURNER-TYPE COMBUSTORS. (U). Allen J. Metzler and Helmut F. Butze. Aug. 14, 1958. 27p. diagrs., tabs.

Authors (2)

The combustion performance of two flame holders, one having a large pilot zone and one consisting of a simple grid of sloping V-gutters, was evaluated at typical conditions for the combustor of a supersonic ducted-fan engine. At a simulated subsonic altitude start condition, only the flame holder having the large pilot zone performed stably. However, the V-gutter grid flame holder was equally capable of subsonic start and acceleration if 1 percent of hydrogen was injected into the V-gutter wake. Maximum combustion efficiencies of 39 percent were attained at conditions simulating a supersonic target run at an altitude of 80,000 feet. Hydrogen addition extended combustor pressure limits but had no significant effect on efficiency.

NACA RM E58G10

USE OF HIGHLY REACTIVE CHEMICAL ADDITIVES TO IMPROVE AFTERBURNER PERFORMANCE AT ALTITUDE. (U). John F. Wanhainen and Joseph N. Sivo. Sept. 30, 1958. 24p. diagrs., photos.

Authors (2)

In separate tests, commercial hydrogen and aluminum trimethyl were injected into a turbojet afterburner for the purpose of promoting combustion in a hydrocarbon-oxygen reaction inhibited by water vapor. The hydrogen, injected into the piloting zones of the afterburner in small amounts, increased the combustion efficiency over the entire afterburner operating range and greatly extended afterburner operating limits. The use of aluminum trimethyl as an additive to the afterburner hydrocarbon fuel resulted in only marginal improvement in afterburner performance.

NACA RM E58D15

PERFORMANCE OF FIVE SHORT MULTIELEMENT TURBOJET COMBUSTORS FOR HYDROGEN FUEL IN QUARTER-ANNULUS DUCT. (U). Robert E. Jones and Warren D. Rayle. July 22, 1958. 41p.

One combustor consisted of an array of U-gutter flame-holders; the other four combustors were manifolded arrays of swirl-can combustor elements. Fuel injection into each swirl-can element was through a tangential sonic orifice. The elements varied in size from 1.5 to 2.0 inches in length and similarly in exit chamber.

NACA RM E57B18

ANALYSIS OF COOLANT FLOW AND PRESSURE REQUIREMENTS FOR A RETURN-FLOW TURBINE ROTOR BLADE DESIGN USING HYDROGEN, HELIUM, OR AIR AS COOLANT. Henry O. Slone and Patrick L. Donoughe. May 7, 1957. 48p. diagrs., tabs.

Authors (2)

An analysis was made to determine the coolant flow and pressure requirements of a return-flow turbine rotor blade design which utilizes hydrogen, helium, or air as the coolant. On the basis of the required coolant flows and pressure changes obtained for conditions representative of a high-altitude supersonic turbojet engine, the return-flow blade design considered would cool adequately over a range of coolant inlet temperatures from 250° to 1000° R using hydrogen, helium, or air.

NACA RM E57C05

EFFECT OF FUEL PROPERTIES ON LINER TEMPERATURES IN A SINGLE TUBULAR TURBOJET COMBUSTOR. Helmut F. Butze. June 3, 1957. 23p. diagrs., photo., tabs.

Author

(M = 2; alt. = 35,000'). Only moderate and not always consistent changes in average liner temperatures were obtained in both a plain and a ceramic-coated liner with three liquid fuels of varying volatility and aromatic content and with one gaseous fuel of low flame emissivity. A high-aromatic fuel produced greater average temperatures than a similar fuel containing no aromatics; differences did not exceed 160° F. Temperatures of the ceramic-coated liner were higher than those of the plain liner.

NACA RM E56L05

HIGH-ALTITUDE PERFORMANCE OF J71-A-11 TURBOJET ENGINE AND ITS COMPONENTS USING JP-4 AND GASEOUS-HYDROGEN FUELS. (U). Ivan D. Smith and Martin J. Saari. May 29, 1957. 63p. diagrs., photo.

Authors (2)

Engine operation with JP-4 fuel at a flight Mach number of 0.8 was satisfactory up to an altitude of about 60,000 to 65,000 feet, and engine operation with marginal combustion stability was maintained up to an altitude of about 80,000 feet. The use of gaseous-hydrogen fuel provided satisfactory engine operation up to the facility operating limit of about 89,000 feet. Operation with JP-4 fuel at an altitude of 80,000 feet, a flight Mach number of 0.8, and rated engine conditions resulted in a decrease in net thrust of 21.5 percent and an increase in specific fuel consumption of 26 percent from the values that would have been obtained had there been no loss in the performance of the components with altitude. When using gaseous-hydrogen fuel at the same operating conditions, the net thrust was approximately 4 percent greater than that obtained with JP-4 fuel because of the increased gas constant of the gaseous-hydrogen exhaust products.

NACA RM E57B06
EVALUATION OF HYDROGEN FUEL IN A FULL-SCALE
AFTERBURNER. (U). Donald E. Groesbeck,
William R. Prince and Carl C. Ciepluch.
Sept. 24, 1957. 40p. diagrs., photos., tabs.

Authors (3)

A total of seven fuel-injector configurations, grouped by type as concentric ring or radial bar, were investigated at a burner-inlet velocity of approximately 600 feet per second over a range of burner-inlet total pressures from 330 to 950 pounds per square foot absolute. Afterburner length was varied from 27 to 69 inches. No flame-stabilizing devices other than the fuel injectors were used.

NACA RM E57K28a
COMBUSTOR PERFORMANCE OF A 16-INCH RAM JET
USING GASEOUS HYDROGEN AS FUEL AT MACH
NUMBER 3.0. (U). Joseph F. Wasserbauer
and Fred A. Wilcox. Jan. 18, 1957. 23p.
diagrs., photo.

Authors (2)

An investigation was conducted in the NACA Lewis 10- by 10-foot supersonic wind tunnel to evaluate the performance of three burner configurations in a 16-inch ram jet with gaseous hydrogen as fuel. Data were obtained over a fuel-air-ratio range from 0.0030 to 0.0260 (stoichiometric = 0.0292) at a free-stream Mach number of 3.0 and 0° angle of attack. The exit nozzle-throat area ratios employed were 0.60 and 0.75. Results of this investigation showed that a flame-holding shroud fitted to an injector-burner greatly improved its performance.

NACA RM E57A11
HIGH-ALTITUDE PERFORMANCE INVESTIGATION OF
J65-B-3 TURBOJET ENGINE WITH BOTH JP-4 AND
GASEOUS HYDROGEN FUELS. (U). Harold R.
Kaufman. Apr. 2, 1957. 35p. diagrs.

Author

With JP-4 fuel, the maximum altitude for stable combustion was from about 60,000 to 65,000 feet, and the ultimate blowout limit was at an altitude of about 75,000 feet. In contrast, the combustion with hydrogen fuel was stable up to the facility altitude limit of 89,000 feet. At rated speed and temperature the thrust with hydrogen fuel was 2 to 4 percent higher and the specific fuel consumption 60 to 70 percent lower than with JP-4 fuel.

NACA RM E57F14
DESIGN AND PERFORMANCE OF FLIGHT-TYPE
LIQUID-HYDROGEN HEAT EXCHANGER. (U). David
B. Fenn, Willis M. Braithwaite and Paul M.
Ordin. Aug. 19, 1957. 34p. diagrs., photos.,
tab.

Authors (3)

A ram-air heat exchanger was used in this fuel system to vaporize the liquid hydrogen. The heat exchanger was evaluated in an altitude test chamber at the NACA Lewis laboratory in conjunction with the complete aircraft fuel system. The experimental results presented in this report indicate that a ram inflow of 1.76 pounds per second was sufficient to vaporize 565 pounds per hour of fuel. At this condition the air-side temperature drop was 82° R, and the heat-transfer coefficient between the tube wall and the fuel was about 69 Btu/(hr) (sq ft) (°R).

NACA RM E56K08a
EXPERIMENTAL STUDY OF FOAM-INSULATED
LIQUEFIED-GAS TANKS. (U). Thaine W.
Reynolds and Solomon Weiss. Jan. 18, 1957.
34p. diagrs.

Authors-(2)

Experiments with liquid nitrogen and liquid hydrogen in Styrofoam-insulated tanks have indicated good agreement between measured and calculated heat-leak rates when the insulation was formed from a single block of material. In a large tank installation where the insulation was applied in sections without sealing the joints, the measured heat leak was about 25 times the calculated value. Measurements of pressure-rise rate due to heat leak into the tanks have shown ground storage time without loss of fuel (herein called no-loss time) of the order of half the theoretical values.

NACA RM E57C29
INVESTIGATION OF AN AFTERBURNING RAMJET
USING GASEOUS HYDROGEN AS FUEL AT MACH
NUMBER OF 3.0. (U). Joseph F. Wasserbauer.
June 17, 1957. 11p. diagrs., photo.

Author

An experimental investigation was conducted in the Lewis 10- by 10-foot supersonic wind tunnel on a 16-inch ramjet that was equipped with an afterburner and used gaseous hydrogen for both the primary and afterburner fuels. The primary nozzle had a contraction ratio of 0.6 while the exit nozzle had a contraction ratio of 0.9. Data were obtained at a free-stream Mach number of 3.0 and zero angle of attack. The results of this investigation illustrate that at a constant diffuser-exit Mach number afterburner operation produces more than twice the thrust available without afterburning.

NACA RM E57F19a
FLIGHT INVESTIGATION OF A LIQUID-HYDROGEN
FUEL SYSTEM. (U). Donald R. Mulholland,
Loren W. Acker, Harold H. Christenson and
William V. Gough. (Incl. App: FLIGHT
INSTRUMENTATION FOR LIQUID HYDROGEN FUEL
SYSTEM. Scott H. Simpkinson and Jacob C.
Woser). Aug. 19, 1957. 57p. diagrs., photos.

Authors (6)

The airplane climbed on JP fuel to cruise altitude, where the engine was shifted to hydrogen fuel and then back to JP fuel after the hydrogen supply was exhausted. Transition was made to hydrogen fuel without serious effects on engine operation. Steady-state and transient operation were both highly satisfactory. Heat-exchanger performance compared favorably with simulated attitude performance in the laboratory. Data are presented to show the effect of tank agitation on fuel pressure and fuel losses.

NACA RM E56J08
EFFECT OF BURNER DESIGN VARIABLES ON PERFORMANCE OF 16-INCH-DIAMETER RAM-JET COMBUSTOR USING GASEOUS-HYDROGEN FUEL. (U).
H. George Krull and Richard R. Burley. Jan. 18, 1957. 38p. diagrs., photo.

Authors (2)

An evaluation of the effect of geometric design variables on the performance of a 16-inch-diameter ram-jet combustor using gaseous hydrogen as a fuel was obtained over a range of combustor total pressures from 7 to 44 inches of mercury absolute. Equivalence ratio was varied from 0.1 to 1.0 at a combustor inlet temperature of 1100° R. Peak combustion efficiencies ranging from 61 to 96 percent were obtained with a burner 18 inches long (measured from fuel injectors to exhaust-nozzle outlet) over a range of burner total pressures from 10 to 35 inches of mercury absolute.

NACA RM E57D23
HYDROGEN FOR TURBOJET AND RAMJET POWERED FLIGHT. (U). Lewis Laboratory Staff. (Papers presented at NACA Conference on Hydrogen for Turbojet and Ram-Jet Powered Flight, LPPL, Apr. 12, 1957). Apr. 26, 1957. 100p. diags., photos.

Conference on Hydrogen for Turbojet and Ram-Jet Powered Flight Apr. 12, 1957

Contents: Combustion characteristics of hydrogen. Combustion in ramjets and afterburners. Combustion in turbojet engines. Fueling problems with liquid hydrogen. Airplane tankage problems with liquid hydrogen. Aircraft fuel system for liquid hydrogen. Flight experience with liquid hydrogen.

NACA RM E57D23
COMBUSTION CHARACTERISTICS OF HYDROGEN. Andrew E. Potter, (Jr.), Frank E. Bellis and Isadore L. Drell.

see p. 1-11 diags.
Hydrogen for turbojet and ramjet powered flight. RM E57D23, Apr. 26, 1957.

Authors (3)

Hydrogen can be burned over a wider range of fuel concentration than any hydrocarbon. It is about 10 times easier to ignite with a spark than a hydrocarbon, and the flame is about ten times harder to blow out once lit. Its burning velocity is higher partly as a result of the greater rate of heat production in the flame. Practically, then hydrogen is substituted for a hydrocarbon in a conventional combustor, performance improves and chamber length may be reduced.

NACA RM E57D23
COMBUSTION IN RAMJETS AND AFTERBURNERS. Roland Breitwieser and H. George Krull.
see p. 13-28 diags.
Hydrogen for turbojet and ramjet powered flight. RM E57D23, Apr. 26, 1957.

Authors (2)

The two areas of research are treated collectively since the inlet pressure, the temperature, the velocity and the general configuration of the two combustors are similar. The data are from small-scale investigations, some recent work on full-scale engines tested in the altitude test chambers, and a few results on a ramjet engine tested in a supersonic wind tunnel.

NACA RM E57D23
COMBUSTION IN TURBOJET ENGINES. E(arl) William Conrad and Lester C. Corrington.
see p. 29-43 diags., photo.
Hydrogen for turbojet and ramjet powered flight. RM E57D23, Apr. 26, 1957.

Authors (2)

Turbojet engines with production or special combustors were operated with hydrogen fuel in altitude test chambers. Altitude was increased until either an engine limitation or a facility limitation was reached. For comparison purposes the engines with the production combustors were also operated with JP-4 fuel.

NACA RM E57D23
FUELING PROBLEMS WITH LIQUID HYDROGEN. Glen Hennings, William H. Rowe and Harold H. Christenson.

see p. 45-57 diags., photo.
Hydrogen for turbojet and ramjet powered flight. RM E57D23, Apr. 26, 1957.

Authors (3)

This paper is primarily concerned with the ground-handling problems associated with the use of liquid hydrogen as an aircraft fuel. The discussion is divided into four parts: (1) the significance of the physical and thermodynamic properties of hydrogen, (2) materials and methods of construction for liquid-hydrogen equipment, (3) safety, and (4) aircraft fueling procedures.

NACA RM E57D23
AIRPLANE TANKAGE PROBLEMS WITH LIQUID HYDROGEN. Solomon Weiss, Thaine W. Reynolds and Loren W. Acker.

see p. 59-69 diags.
Hydrogen for turbojet and ramjet powered flight. RM E57D23, Apr. 26, 1957.

Authors (3)

Relatively light weight insulated tanks have been investigated experimentally in order to gain an appreciation of some of the factors involved in the design of tanks insulated with a foamed plastic material.

NACA RM E57D23
AIRCRAFT FUEL SYSTEM FOR LIQUID HYDROGEN. Paul M. Ordin, David B. Penn and Edward W. Otto.
see p. 71-83 diags., photos.
Hydrogen for turbojet and ramjet powered flight. RM E57D23, Apr. 26, 1957.

Authors (3)

During the time NACA has been engaged in this project, studies have been completed on the aircraft system in the altitude facility, on the installation of the system in the B57 aircraft, and on the operation of the aircraft on hydrogen fuel at an altitude of over 49,000 ft. and a Mach number of 0.72. The flight and design problems encountered in the project are discussed.

NACA RM E57D23
FLIGHT EXPERIENCE WITH LIQUID HYDROGEN. Donald R. Mulholland, Joseph S. Algranti and William V. Gough, Jr.
see p. 85-98 diags., photos.
Hydrogen for turbojet and ramjet powered flight. RM E57D23, Apr. 26, 1957.

Authors (3)

The objectives of the flight-test phase of this research program were to construct a workable fuel system and demonstrate its feasibility during flight and to uncover areas in which laboratory research could be best applied to further work in this field.

NACA RM E57D23
ALTITUDE-CHAMBER EVALUATION OF AN AIRCRAFT LIQUID-HYDROGEN FUEL SYSTEM USED WITH A TURBOJET ENGINE. (U). Willis M. Braithwaite, David B. Penn and Joseph S. Algranti. Aug. 19, 1957. 29p. diags., photos

Authors (3)

The fuel system permits engine operation on hydrogen, JP-4 fuel, and combinations of the two introduced separately into the engine. The fuel system consisted of (1) a stainless steel wingtip fuel tank for liquid hydrogen, (2) a ram-air heat exchanger to vaporize the fuel, and (3) a regulator for the hydrogen flow, which was controlled by the regular engine throttle. The engine was modified to the extent of adding a separate fuel manifold and injection tubes for the hydrogens. Over three-fourths of the 38 transitions from JP-4 fuel to hydrogen were satisfactory. The other transitions were characterized by speed variations.

NACA RM E57D22

ANALYSES FOR TURBOJET THRUST AUGMENTATION WITH FUEL-RICH AFTERBURNING OF HYDROGEN, DIBORANE, AND HYDRAZINE. (U). James F. Morris. June 18, 1957. 21p. diagrs., tab.

Author

When compared at equal liquid weights, hydrogen, diborane, or hydrazine, burned at higher than stoichiometric fuel-air ratios, can produce thrusts that are, to some limit, greater than those for a 220-second specific-impulse rocket combined with stoichiometric afterburning of the turbojet fuel. At the conditions analyzed, this limit for liquid hydrogen is a liquid-air ratio of 0.16; the corresponding thrust is 27 percent greater than that for stoichiometric afterburning alone. Fuel-rich afterburning of 700° K hydrogen can yield augmented thrusts greater than those for stoichiometric combustion of 700° K hydrogen and 400° K air augmented with a 321.6-second specific-impulse rocket.

NACA RM E57C8

EXPERIMENTAL EVALUATION OF "SWIRL-CAN" EXHAUSTS FOR HYDROGEN FUEL COMBUSTOR. (U). Warren D. Rayle, Robert E. Jones, and Robert Friedman. May 13, 1957. 31p. diagrs., photo., tabs.

Authors (3)

The elements varied from 1.5 to 2.5 inches in length and from 1.3 to 2.0 inches in diameter and served as combined fuel injectors and flame stabilizers. Combustion efficiency of the individual elements exceeded 70 percent at a reference velocity of 180 feet per second, a pressure of 5.7 inches of mercury absolute, and an inlet temperature of 350° F in a combustor length of about 13.5 inches. Conical and cylindrical elements with an inlet that was covered with an orifice plate blocking about 75 percent of the area operated stably with hydrogen to velocities as high as 280 feet per second at the same inlet air pressure and temperature.

NACA RM E57F19

DESIGN AND PERFORMANCE OF FUEL CONTROL FOR AIRCRAFT HYDROGEN FUEL SYSTEM. (U). Edward W. Otto, Kirby W. Hiller and Phil S. Ross. Aug. 19, 1957. 22p. diagrs.

Authors (3)

Hydrogen was carried in the fuel tank as a cold liquid, vaporized in a heat exchanger, and injected into the combustion chamber as a gas. The fuel was forced through the system by pressurizing the tank. The type of control that appeared most capable of coping with the characteristics of this system was a flow regulator. The flow regulator designed for the system was a differential reducing-valve type. Speed control of the engine was obtained by coupling the hydrogen regulator to the JP-4 fuel control. Because of the hydrogen regulator was designed for high dynamic response, the performance of the complete speed-control system was essentially the same on hydrogen as on JP-4 fuel.

NACA RM E55J17a

EFFECT OF COMBUSTION GAS PROPERTIES ON TURBOJET-ENGINE PERFORMANCE WITH HYDROGEN AS FUEL. (U). Robert E. English. Apr. 10, 1956. 11p. diagrs.

Author

Simple adjustment of turbojet engine cycle calculations based on JP-4 fuel for the increase in heating value when hydrogen is substituted for JP-4 resulted in the following errors: Fuel specific impulse was as much as 3 percent high; thrust per unit airflow was as much as 5 percent low; airflow per unit of turbine frontal area was as much as 1 percent low.

NACA RM E56E14

TURBOJET PERFORMANCE AND OPERATION AT HIGH ALTITUDES WITH HYDROGEN AND JP-4 FUELS. (U). William A. (dam) Fleming, H. (arold) R. Kaufman, J. (ames) L. Harp, Jr. and L. (ouls) J. Chelko. Aug. 7, 1956. 46p. diagrs.

Authors (4)

Component and over-all performance data were obtained with JP-4 fuel over a range of altitudes from about 40,000 to 80,000 feet at a flight Mach number of 0.8, and with hydrogen fuel at altitudes from 70,000 to 90,000 feet at the same flight Mach number.

NACA RM E56D24

PERFORMANCE OF A SHORT COMBUSTOR AT HIGH ALTITUDES USING HYDROGEN FUEL. (U). Joseph N. Sivo and David B. Fenn. Aug. 7, 1956. 20p. diagrs.

Authors (2)

Performance characteristics of a 16-inch annular-type combustor installed in a full-scale engine using gaseous-hydrogen fuel were obtained at simulated altitudes from 56,000 to 86,000 feet at a flight Mach number of 0.8. Combustion efficiencies of 86 percent were obtained at 86,000 feet (combustor pressure, 420 lb/sq ft abs). Combustor blowout was not encountered during this investigation.

NACA RM E56A19a

AN ANALYTIC STUDY OF TURBOJET-ENGINE THRUST AUGMENTATION WITH LIQUID HYDROGEN, PENTABORANE, MAGNESIUM SLURRY, AND JP-4 AFTERBURNER FUELS AND A 220-SECOND IMPULSE ROCKET. (U). James P. Morris. Aug. 15, 1956. 29p. diagrs., tab.

Author

Augmented thrust and total fuel flow for the five augmentation methods were computed for four turbojet engines and several operating conditions. The order of performance for the afterburner fuels and the rocket was independent of the variables examined. Liquid hydrogen and pentaborane, in that order, gave the lowest fuel consumption. These two afterburner fuels also dropped specific fuel consumption below that for a turbojet engine alone at certain flight conditions.

NACA RM E56I19a

ANALYSIS OF TURBOJET AND RAM-JET ENGINE CYCLES USING VARIOUS FUELS. E. Clinton Wilcox, Richard J. Weber and Leonard K. Tower. Nov. 27, 1956. 47p. diagrs.

Authors (3)

Thrust per pound of airflow and engine overall efficiency are presented for afterburning and nonafterburning turbojets up to a flight Mach number of 3.0 and for ram-jets up to a Mach number of 4.0. Fuels considered are hydrogen, pentaborane, ethylene decaborane, and a conventional hydrocarbon. Differences of 10 percent or more in thrust and over-all efficiency are found in some cases because of the variation in combustion gas properties when different fuels are used.

NACA RM E56427
METHOD FOR SHORTENING RAM-JET ENGINES BY
BURNING HYDROGEN FUEL IN THE SUBSONIC
DIFFUSER. (U). (Adolph) J. Cervantes and
(John) W. Swadlow. Oct. 17, 1956. 39p.
diags.

Authors (2)

Merging of the subsonic diffuser and the combustor appears feasible with a highly reactive fuel such as hydrogen. A typical ram-jet operating conditions the flame speed of this fuel is high enough for burning to be stabilized at velocities of 600 feet per second by means of a fuel injected alone. Thus it was possible to seat the flame at a station where the Mach number was 0.4 to 0.5 rather than 0.2 as is done conventionally. Besides the decrease in engine length and weight, a further gain was found due to a uniform exhaust-gas temperature distribution which varied as little as 47 percent from the mean of 2100°R. Also, combustion efficiency was improved at lean fuel-air mixtures; values of 90 percent or higher were obtained at equivalence ratios as low as 0.1. However, the total-pressure loss coefficient increased to 9.8 from 2.6 for the conventional system at a temperature ratio across the combustor of 2.8. An estimate of the net effect of these factors was made on the basis of range potential of a ram-jet-powered missile. At a lean basis of range potential of a ram-jet-powered missile. At a lean fuel-air ratio the gain in range was estimated as 16 percent above that of hydrogen fuel used in a conventional configuration.

NACA RM E56130
TESTS WITH HYDROGEN FUEL IN A SIMULATED AFTERBURNER. (U). (William) R. Kerslake and E.E. Dangle. July 2, 1956. 24p. diags., tab.

Authors (2)

An investigation was conducted in a 16-inch-diameter simulated afterburner using gaseous hydrogen fuel. No flameholder was used with a multipoint fuel injector. The burner length was varied from 9.5 to 38 inches. The afterburner-inlet conditions were: temperature of 1200° or 1500° F, pressure of 14 to 44 inches mercury absolute, and velocity of 300 to 780 feet per second. The measured combustion efficiency ranged from 85 to 98 percent over an equivalence-ratio range of 0.2 to 1.0. The cold-flow pressure-drop coefficient was 1.0 for the system. Spontaneous ignition was always possible at temperatures above 1200° F but was not possible below 1100° F for all pressures and velocities tested.

NACA RM E56116
PERFORMANCE OF A SHORT TURBOJET COMBUSTOR WITH HYDROGEN FUEL IN A QUARTER-ANNULUS DUCT AND COMPARISON WITH PERFORMANCE IN A FULL-SCALE ENGINE. (U). Robert Friedman, Carl T. Norgren and Robert E. Jones. July 2, 1956. 35p. diags., photos., tab.

Authors (3)

Satisfactory combustion efficiencies and outlet radial-temperature distributions at low total-pressure loss were obtained in an experimental, quarter-annulus combustor with hydrogen fuel at total pressures as low as 5.7 inches of mercury absolute. The combustor was 25 percent shorter than previous models for liquid hydrocarbon fuels. Similar performance was obtained from this combustor design operated with hydrogen in a full-scale engine.

NACA RM E55118
EXPERIMENTAL EVALUATION OF GASEOUS HYDROGEN FUEL IN A 16-INCH-DIAMETER RAMJET ENGINE. (U). E.E. Dangle and William R. Kerslake. Mar. 6, 1956. 34p. diags., tab.

Authors (2)

Operating conditions simulated Mach numbers of 2.5 and 3.0 at altitudes of 51,000 to 66,000 feet and 63,000 to 89,000 feet, respectively. Combustor modifications included to two fuel-injector designs, several combustor lengths, and tests with and without flameholders. Combustion efficiencies were measured by three techniques: a heat balance after adding quench water, direct temperature measurement by thermocouples, and total pressure measurements at the exit of a choked convergent exhaust nozzle. The agreement among the three methods was reasonably good. A combustor length of only 16 inches gave combustion efficiencies of 90 percent or greater for equivalence ratios from 0.5 to stoichiometric. The engine started at pressures as low as 7 inches of mercury absolute and ran very smoothly at all operating conditions.

NACA RM E56118a
SOME DESIGN AND OPERATIONAL CONSIDERATIONS OF A LIQUID-HYDROGEN FUEL AND HEAT-SINK SYSTEM FOR TURBOJET-ENGINE TESTS. (U). Lester C. Corrington, Kenneth L. Thornbury, and Glen Hennings. Dec. 18, 1956. 34p. diags., photos.

Authors (3)

Liquid hydrogen was used as a heat sink for turbine-cooling in a high-temperature modified turbojet engine. The turbine cooling air was refrigerated by cold hydrogen in a heat exchanger, and the engine was operated with this hydrogen as fuel. Cooling-air temperatures of 160° to 220° R were obtained at the heat-exchanger exit with cooling-air flow rates of 3 to 14 percent of the engine airflow. The fuel and cooling-air systems and the problems encountered in their operation are discussed. Information is presented on the properties of liquid and gaseous hydrogen that are pertinent to such a fuel-system design.

NASA TM X-252
FLIGHT OPERATION OF A PUMP-FED LIQUID-HYDROGEN FUEL SYSTEM. (U). David B. Fenn, Loren W. Acker and Joseph S. Algranti, LeRC. Apr. 1960. 16p.

NASA CC-E-428

A B57 bomber was flown at an altitude of 50,000 feet and a Mach number of 0.75 with hydrogen in one of the two turbojet engines. The liquid-hydrogen pump was a five-cylinder positive-displacement type submerged in the bottom of the hydrogen tank. Some oscillations of pump speed and outlet pressure were observed, but the hydrogen flow regulator was able to maintain constant engine speed.

NACA RM E55129a

PRELIMINARY ATTEMPTS AT ISOTHERMAL COMPRESSION OF A SUPERSONIC AIR STREAM. E(uene) Ferchonok and F(red) (A.) Wilcox. Jan. 25, 1956. 33p. diagrs., photos., tab.

Authors (2)

When applied to a supersonic inlet diffuser at both $M_0 = 1.9$ and 3.0 , the process produced large total-pressure losses due to the momentum exchange between the inlet air stream and the coolant as expected, but the total-pressure increase associated with evaporative cooling was not observed. Tests at $M_0 = 3.0$ with a heated air stream and multipoint upstream injection suggest that some improvement in the process might be obtained with a full-scale inlet at the high stagnation temperature of supersonic flight.

NACA RM E55028a

LIQUID HYDROGEN AS A JET FUEL FOR HIGH-ALTITUDE AIRCRAFT. (U). Abe Silverstein and Eldon W. Hall. Apr. 15, 1955. 56p. diagrs., tabs.

Authors (2)

The physical properties of liquid hydrogen that have been used in the present analysis are summarized. The heating value of the fuel is 51,571 Btu per pound, which is about 2.75 times the heating value of the average hydrocarbon fuel (JP-4) in current military use. This analysis shows that within the state of the art and progress anticipated, aircraft designed for liquid-hydrogen fuel may perform several important military missions that comparable aircraft using hydrocarbon (JP-4) fuel cannot accomplish. These include (1) subsonic bomber and reconnaissance flights of over 5500 nautical mile radius without refueling with an altitude over the target of 80,000 feet; (2) supersonic bomber (Mach 2.0) and reconnaissance flights (Mach 2.5) of about 1500 nautical mile radius with altitudes over the target of 75,000 feet for the bomber and 80,000 feet for the reconnaissance aircraft; (3) supersonic fighter aircraft with a combat radius (Mach 2.5) of 700 nautical miles and a combat altitude of 80,000 feet.

NACA RM E55F22

AIRCRAFT-FUEL-TANK DESIGN FOR LIQUID HYDROGEN. (U). T(haine) W. Reynolds. Aug. 9, 1955. 27p. diagrs., tab.

Author

Some of the considerations involved in the design of aircraft fuel tanks for liquid hydrogen are discussed herein. Several of the physical properties of metals and thermal insulators in the temperature range from ambient to liquid-hydrogen temperatures are assembled. Calculations based on these properties indicate that it is possible to build a large-size liquid-hydrogen fuel tank which (1) will weigh less than 15 percent of the fuel weight, (2) will have a hydrogen vaporization rate less than 30 percent of the cruise fuel-flow rate, and (3) can be held in a stand-by condition and readied for flight in a short time.

NACA RM E55114
PERFORMANCE OF A SINGLE FUEL-VAPORIZING COMBUSTOR WITH SIX INJECTORS ADAPTED FOR GASEOUS HYDROGEN. (U). Jerrold D. Wear and Arthur L. Smith. Nov. 30, 1955. 22p. diagrs., tabs.

Authors (2)

The combustor was operated over a range of inlet-air pressures from 5.3 to 24.0 inches of mercury absolute and inlet-air reference velocities from 60 to 100 feet per second. The combustion efficiencies obtained with the six configurations varied from about 65 to 95 percent for a combustor temperature-rise range of 200° to 1400° F. At a temperature rise of 1200° F (near-rated engine conditions), the spread in efficiencies of the six configurations was about 5 percent. Efficiencies in the range of 65 to 85 percent were obtained at operating conditions beyond the burning range of conventional jet fuels. A fuel-injector configuration that fed only gaseous hydrogen fuel into the standard liquid-fuel-vaporizing tubes generally gave the highest efficiencies. This configuration minimizes the possibility of combustion in the fuel-vaporizing tubes and could be easily adapted to the full-scale engine combustor.

NACA RM E54L30a

LOW-PRESSURE PERFORMANCE OF A TUBULAR COMBUSTOR WITH GASEOUS HYDROGEN. Edmund R. Jonash, Arthur L. Smith and Vincent P. Hlevin. May 9, 1955. 37p. diagrs., tabs.

Authors (3)

An investigation was conducted to determine the combustion performance characteristics of gaseous hydrogen fuel in a single tubular turbojet combustor. The combustor was operated over a range of inlet-air pressures from 3.3 to 14.3 inches of mercury absolute. Reference velocities as high as 174 feet per second were investigated to pressures as low as 0.0 inches of mercury absolute; reference velocities at lower pressures were limited to lower values by the test facility. Limited comparison tests were conducted with gaseous propane fuel.

METHANOL: OLD HELP FOR A NEW CRISIS.

F.E. Bryson.

Machine Design, Mar.21,1974, p.20,21,23,24,26.

To switch our universal fuel from a petroleum to an alcohol base would challenge some of the most potent and entrenched economic forces in the world. Yet, such a change might make good sense from both an economic and an environmental standpoint.

THE BEST SUBSTITUTE FOR PETROL MAY BE PETROL.

N. Valery.

New Scientist, Jan.24,1974, p.203-205.

Hydrogen may be heralded as the ultimate fuel for motor cars and aircraft, but it has serious problems. A more practical fuel would be methanol made from coal, or even, synthetic petrol manufactured from basic ingredients.

METHANOL AS A GAS SUBSTITUTE.

J.F. Pink.

Energy Pipelines Systems, v.1, no.6, June 1974, p.55-56.

TITLE: Methanol - The "New Fuel" from Coal
AUTHOR: Mills, G.A.; Harney, B.B.
COMPANATE AUTHOR: U.S. Dept. of Interior, Bureau of Mines, Division of Coal, Energy Research
PUBLICATION DESCRIPTION: Chentech, p. 26-31, 20
Ref.

PUBLICATION DATE: 1974, January
ABSTRACT: Recent tests have indicated that methanol, either alone or mixed with gasoline, can be used as an automotive fuel with few engine modifications. Using modifications of coal gasification processes which are already under development, the manufacture from this feed seems economically attractive. It is possible that it might be better to manufacture and ship methanol from overseas than LNG. (JMC)

THE HYDROGEN ECONOMY MIAMI ENERGY (THEME) CONFERENCE.

Presented by The School of Engineering & Environmental Design, Univ. Miami, Coral Gables, Florida.

Sponsored by The National Science Foundation, Defense Advanced Research Projects Agency, and The School of Continuing Studies, Univ. of Miami.

Miami Beach, Florida, Mar.18-20,1974.

THE METHANOL ECONOMY

T. B. Reed, Massachusetts Institute of Technology.
Lexington, Massachusetts

TITLE: Methanol From Coal Can Be Competitive With Gasoline

AUTHOR: Harris, E.D.; Davison, E.B.
COMPANATE AUTHOR: Texas A & M University
ADDRESS: College Station, TX
PUBLICATION DESCRIPTION: Oil and Gas Journal, 71(51), 70-72

PUBLICATION DATE: 1973, December 17
ABSTRACT: Methanol can be used as a motor fuel instead of gasoline, with certain advantages and few disadvantages. A big advantage is reduced pollution. Calculations indicate that methanol could be manufactured directly from coal and be competitive with gasoline costing 16.3¢ per gallon (tax-free). (JMC)

AICHE Symposium Series. v.69, no.135 1973

THE PETROLEUM/PETROCHEMICAL INDUSTRY AND THE
ECOLOGICAL CHALLENGE. George H. Cummings, ed.
(Contains abstracts of papers presented at the
Seventy-fourth National Meeting of the AIChE
in New Orleans this year).

American Inst. of Chemical Engineers

DESIGN AND PERFORMANCE OF THE ICI

100 ATMOSPHERES METHANOL PLANT -18-74
J. B. Horsley, P. L. Rogerson, and R. H. Scott 90

1973

METHANOL: A VERSATILE FUEL FOR IMMEDIATE USE. Reed, T. B.; Lerner, R. M. (Massachusetts Inst. of Tech., Cambridge). Science; 182: No. 4119, 1299-1304 (28 Dec 1973).

The advantages of using methanol as a fuel and the ways in which it can be utilized immediately into the fuel economy are discussed. Methanol can be made from natural gas, petroleum, coal, oil shale, wood, farm and municipal wastes; easily stored in conventional fuel tanks and shipped in tank cars, tank trucks, and tankers; can be transported in oil and chemical pipelines. Up to 15% of methanol can be added to commercial gasoline in cars now in use without modification to the engines. The methanol-gasoline mixture results in improved economy, lower exhaust temperature, lower emissions, and improved performance compared to the use of gasoline alone. Methanol can be used for most other fuel needs, and is especially suited for use in fuel cells for generating electricity. (35 references). (MCW)

(BNL-17800) METHANOL AS A FUEL IN THE URBAN ENERGY ECONOMY AND POSSIBLE SOURCE OF SUPPLY. Selberg, M.; Salzano, F. J.; Beller, M.; Manowitz, B. (Brookhaven National Lab., Upton, N. Y.). Apr 1973. 20p. Dep. NTIS \$3.00.

The potential for the development of methanol technology as a source of energy in the urban economy is discussed. The manufacturing technology involves the conversion of coal to gasoline or other liquid petroleum products, the conversion to some synthetic liquid fuel forms such as methanol or ammonia, and the conversion of coal to a gaseous fuel such as natural gas or hydrogen. The technology for the synthesis of methanol is readily available and involves production by reforming methane, petroleum, or gasification of coal. The processes for the production of methanol are discussed and the economic feasibility is presented. (JCW)

METHANOL COMPETITIVE WITH LNG ON LONG HAUL.
B. Dutkiewicz.

Oil & Gas J., 71(18), p.166-178, 1973.

Viability of methanol fuel depends on: distance of sea haul, need for clean burning fuels in the consumer country, and cost compared to alternate forms of clean burning fuels.

1973

THE METHANOL ALTERNATIVE NOW.....

Tech. Rev. v.76, no.5, Mar./Apr.1974, p.61-62.

Methanol, an alcohol with many of the same transport, storage, and usage characteristics as gasoline. Methanol can be made from almost any other fuel insuring a flexibility of production beyond that of hydrogen or even gasoline.

OUTLOOK BRIGHT FOR METHYL-FUEL.

Environmental Sci.& Tech., v.7, no.11, Nov.1973, p.1002,3.

Methyl fuel can extend present energy supplies and significantly reduce pollution as well.

74-000394

USE OF ALCOHOL IN MOTOR GASOLINE - A REVIEW. 36p.

UNCL

Aug. 1971

Keller, J.G. Douthit, W.H. Long, W.C. et al.

American Petroleum Inst.

API-Pub-4082

Development and application of a mathematical model of the methanol synthesis, Bakemeier, Heinrich, Peter R. Laurer, and Wolfgang Schröder, *Chem. Eng. Progr. Symposium Ser. No. 98, 66, p. 1 (1970)*.

Key Words: A. Synthesis-8, 9, Methanol-2, Reaction Kinetics-8, Mathematical Model-8, Pilot Plant Scale-0. B. Design-8, Reactors-2, Synthesis-4, Methanol-2, Mathematical Model-10.

Abstract: The reaction kinetics in methanol synthesis of the prescribed reaction mechanism of the major reactions and the important side reactions have been obtained from pilot plant data. The reaction kinetics have been calculated from integral measurements for the four main reactions. A mathematical model was developed from the experimental data and used for design of different methanol reactors and circulating systems. Plant operating results correspond well with design calculations.

The PVT behavior of methanol at elevated pressures and temperatures, Finkelstein, Ronald S., and Leonard I. Stiel, *Chem. Eng. Progr. Symposium Ser. No. 98, 66, p. 11 (1970)*.

Key Words: Methanol-1, PVT Behavior-2, Temperature-6, Pressure-7, Polar Fluids-8, Fourth-Parameter-9, Constant Volume Cell-10.

Abstract: Experimental PVT data have been obtained for methanol by the constant volume method for temperatures from 200° to 300°C. and pressures from 1,200 to 10,000 lb./sq. in. The experimental data are estimated to be accurate to within 0.4%. Smoothed compressibility factors are presented for this region and are found to be consistent with data previously reported for pressures to 3,000 lb./sq. in. The compressibility factor of methanol is also analyzed by the fourth-parameter approach.

A review of volumetric, thermodynamic, and other physical properties for methanol, Eubank, P. T., *Chem. Eng. Progr. Symposium Ser. No. 98, 66, p. 16 (1970)*.

Key Words: Methanol-9, Physical Properties-8, Correlation-10, Evaluation-10, Experimental Data-1, Temperature-6, Pressure-2, 7, Refractive Indexes-2, 7, Saturated Properties-2, 7, Second Virial Coefficients-2, 7, Fluid Density-2, 7.

Abstract: A general survey of physical property data for liquid and gaseous methanol is presented. Refractive index, density, heat capacity, entropy, and heat of combustion data are considered for the liquid state together with vapor pressure, heat of vaporization, critical properties, saturated liquid and vapor densities for the saturated envelope and virial coefficients, PVT, heat capacity, and thermodynamic properties for the gas state.

Removal of organic and inorganic carbonyls from methanol by resin techniques, Dehn, J. S., J. M. Boyd, J. L. Slate, and H. S. Leach, *Chem. Eng. Progr. Symposium Ser. No. 98, 66, p. 24 (1970)*.

Key Words: Purification-8, Removal-8, Methanol-7, Ion-Exchange Resins-10, Carbonyl Compounds-3, Metal Carbonyls-3, Weak Acid-0, Aldehydes-3, Ketones-3, Ion Carbonyl-3.

Abstract: Ion-exchange resin techniques have been developed and commercially demonstrated for the removal of organic and metal carbonyls from methanol. These carbonyls are difficult to remove completely by using conventional separation techniques. The processing schemes, plant test results, and economic potential of these techniques in methanol purification systems will be presented.

Imperial Chemical Industries' low pressure methanol plant, Rogerson, P. L., *Chem. Eng. Progr. Symposium Ser. No. 98, 66, p. 28 (1970)*.

Key Words: Reforming-8, 10, Synthesizing-8, Distillation-8, Compression-8, Catalyzing-8, Naphtha-1, 9, Methanol-1, 2, 9, Centrifugal-10, Gas Distribution-10, Computer-10, Savings-4, Activity-4, 6, Quench-4, Mixing-4, Equilibrium-6, Pressure-5, 7, Temperature-5, 7, Pressure Drop-3, 7, Hydrogen-1, Carbon Oxides-1, Copper-1, 5, Steam-1, Methane-2, 3, By-products-2, 3, Sulfur-3, Dust-3, Catalyst-5, ICI-0, Billingham-0.

Abstract: A methanol plant using a copper based catalyst has been built and successfully operated by ICI at Billingham, England. The activity of the copper catalyst is sufficiently high to allow methanol synthesis at temperatures below 300°C. and at a pressure of 50 atm. The synthesis gas is derived from a naphtha steam reformer and is compressed by centrifugal machines. A computer has been installed for on-line control and data logging. By-products are removed by two-column distillation.

Process control in large, single-train methanol plants, McCurdy, P. mer, *Chem. Eng. Progr. Symposium Ser. No. 98, 66, p. 35 (1970)*.

Key Words: A. Reforming-8, Hydrocarbons-1, 9, Hydrogen-2, Carbon Monoxide-2, Carbon Dioxide-2, Methane-3, Argon-3, Steam-6, Temperature-6, Shift Conversion-6, Ratios-7, Purity-7. B. Production-8, Synthesizing-8, Methanol-9, Instrumentation-10. C. Control-8, Analysis-8, Processes-9, Reforming-9, Synthesis-9, Computers-6, 10, Digital-0, Models-10, Dynamic Regulation-10, Rates-6, 7, Ratios-6, 7, Temperature-6, 7, Quality-6, 7.

Abstract: Despite the apparent simplicity of the unit operations in a modern methanol plant, the problems encountered in calculating, achieving, and maintaining an economically desirable combination of synthesis components cannot be entirely resolved by conventional control methods. The correction of errors in the synthesis loop through properly timed changes in several reformer set points can best be performed by a process digital computer, backed up by reliable data from stream instrumentation. This paper outlines a computer application of reforming and synthesis simulators to dynamic regulation and illustrates the value of additional stream analyzers. The mechanisms for increasing daily production are also described.

Design, development, and operation of high pressure syn gas compressors in methanol production, Zech, W. A., Chem. Eng. Progr. Symposium Ser. No. 98, 66, p. 41 (1970).

Key Words: Synthesis Gas-1, Methanol-2, Ammonia-2, Liquid Slug-3, Compression-4, High Pressure-5, 6, Speed-6, Pressurization-7, Synthesizing-8, Production-8, Specific Speed-8, Steam-9, Centrifugal Compressors-10, 553B-0, 463B-0, 272B4+4-0, 272B4+2R-0, 272B6+2R-0.

Abstract: High pressure equipment for methanol service is applicable to plant outputs from 600 to 2,000 tons/day or more. Machines with case pressure ratings from 1,000 to 6,500 lb./sq. in. are in service. Frame speeds to 16,000 rev./min. with a line of developed and tested impellers capable of handling flows from 150 to 8,500 ACFM offer complete flexibility in driver selection and arrangement and insure good efficiencies even for the smaller plant. Major design features include method of attaching piping to machined flats on the case, back to back impeller arrangement, option of thrust bearing location and direction from which bundle may be pulled for inspection and service, elimination of internal lube oil piping, shear ring method of head retention, availability of a wide range of materials applicable to most any service, and surface coating of components with stainless steel, phenolic, or galvanizing as required.

Present methanol manufacturing costs and economics using the ICI process, Kenard, R. J., Jr., and N. M. Nimmo, Chem. Eng. Progr. Symposium Ser. No. 98, 66, p. 47 (1970).

Key Words: Economics-8, Methanol-9, Pressure-6, Carbon Dioxide Addition-6, Capacity-6, Costs-7, By-Product Hydrogen-7, Natural Gas-1, Naphtha-1, Methanol-2, By-Product Hydrogen-2, Methanol-4, Pressure-5, Power-Gas/ICI Low Pressure Methanol Process.

Abstract: The introduction of the ICI low pressure methanol process to the industry over the past 18 mo. has led to a considerable rethink on the fundamentals of methanol production cost economics. Several projects over a wide capacity range are now well into the design phase, all utilizing the same basic process concept of low pressure synthesis but in fact each based on distinctive flow sheets designed to achieve minimum production costs for their particular locations incorporating specific raw material and utility cost data. Production cost data for a wide range of plant capacities is reviewed and variations to the basic flow sheet discussed.

Methanol: its technology and economics, Strolzoff, Samuel, Chem. Eng. Progr. Symposium Ser. No. 98, 66, p. 54 (1970).

Key Words: Methanol-2, Natural Gas-1, Hydrogen-1, Carbon Monoxide-1, Carbon Dioxide-1, Synthesis-8, Catalysts-10, Reaction Equilibrium-8, Kinetics-8, Conversion-8, Chemical Process-9, ICI Low Pressure Process-9, High Pressure Process-9, Equipment Costs-10, Utilities Costs-10, Purification-2, Fractionation-2, Centrifugal Compressors-10, Piston Type of Compressors-10, Isothermal Reactors-10, Adiabatic Reactors-10, Yield-2, Quenching Type of Reactor-10, Use Pattern-4, World Production-2, Yield-2.

Abstract: The chemistry and numerical data of thermodynamics, and kinetics of methanol synthesis from hydrogen and carbon oxides are reviewed. The method of calculating the conversion of a given synthesis gas to methanol is given. The composition and preparation of catalysts are discussed. The operating conditions for the two major industrial processes of methanol synthesis and product purification are given; these processes are generally designated as the high pressure process and the low pressure process. They are compared with respect to equipment costs, utilities consumption, and adaptability to a given single-train plant capacity, and local market conditions. Process flow diagrams are shown.

D. ORGANIC WASTES AND WASTE HEAT

1974

CONVERTING GARBAGE INTO ENERGY.

Business Week, Mar.30,1974, p.42,46.

Oil or gas from pyrolysis of garbage, methane from sewage plants and landfills.

Environment, v.16, no.2, Mar.1974.

POWER FROM TRASH

34

William C. Kasper

Solid wastes could make a modest but important contribution to energy supplies and be transformed from a problem to an asset. Direct burning and manufacture of fuel from wastes are discussed.

A PERPETUAL METHANE ECONOMY - IS IT POSSIBLE?

D.L. Klass.

Chemtech, Mar.1974, p.161-168.

Why not use the sun to grow stuff and then let bugs turn it into methane fuel.

GARBAGE ROUTES TO METHANE.

L.J. Ricci.

Chem. Engineering, v.81, no.11, May 27,1974, p.58-60.

Spurred by solid-waste-disposal problems and increasing fuel costs, more and more companies and public agencies are looking at methane-from-garbage as an energy supplement.

ECONOMICS OF RESOURCE RECOVERY FROM MUNICIPAL SOLID WASTE. Abert, J. G.; Alter, H.; Bernheisel, J. F. (National Center for Resource Recovery, Washington, DC). Science; 183: No. 4129, 1052-1059(15 Mar 1974).

Based on the composition of the refuse stream, recovery is essentially a two-phase process: materials recovery of glass, metals, and some paper and recovery of the organic portion and reuse through conversion, probably as a source of energy. Schemes are shown of front end recovery referring to materials recovery with disposal of the organic portion by conventional means and back end recovery referring to the recovery of the organic portion and its reuse as fuel or as raw material for a product. An analysis was made based on the assumption that the value of the fuel recovered exactly offset the additional capital and operating costs of the utility that burns it. Costs could sway either way, but it is assumed that the materials-plus-energy case seems realistic. (23 references) (MCW)

ENERGY FROM SOLID WASTES 1974.

F.H. Jackson.

Noyes Data Corp., N.J., 197-.

N74-20069# Bureau of Mines, Bartlesville, Okla. Energy Research Center.
WASTE LUBRICATING OIL RESEARCH: AN INVESTIGATION OF SEVERAL REFINING METHODS
 M. L. Whisman, J. W. Goetzinger, and F. O. Cotton 1974 29 p refs
 (BM-R1-7884) Avail: NTIS HC \$4.50

Several commercial processes for reclaiming used lubricating oil were duplicated on a laboratory bench scale. Laboratory tests were selected and in some instances modified to determine the physical properties of each oil produced. In addition, the hydrocarbon composition of some samples was determined using a liquid chromatographic technique, and compared with the composition of new oil in order to determine the severity of the re-refining additive package for further estimates of quality as determined by wear, corrosion, foaming, and oxidation stability tests. Additionally, several samples of commercially re-refined oil and new oil were obtained and physical properties were determined for comparative studies.

Author

FLUID-BED PYROLYSIS OF SOLID WASTE MATERIALS. Hurton, R. R. III; Haffin, R. C. (Univ. of West Virginia, Morgantown). Combustion; 45: No. 8, 13-19 (Feb 1974).

Pyrolysis is the thermal decomposition of carbonaceous materials in the absence of oxygen. The yields of gases, liquids, and solids are based on the chemical structure, size, and shape of the material to be pyrolyzed, the temperature for decomposition, and the heating rate. The pyrolysis products can be burned in the presence of oxygen, to form carbon dioxide, water, and heat. Kaiser et al., used simple retort apparatus to pyrolyze the individual components found in municipal refuse at atmospheric pressure and 1500°F. Typical waste analysis included paper, plastic, leather, rubber, food wastes, grass, tree leaves, wood, textiles, glass, ceramics, stones, and metals. Municipal solid waste was found to have a high H/C ratio and is potentially attractive for the production of fuel gas. High conversions of wastes to low molecular weight gases could be achieved in a fluidized bed. Municipal solid wastes do not need pretreatment. (M'W)

N74-19706# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
CLEAN FUELS FROM BIOMASS
 Y. Y. Hsu 1974 23 p refs Presented at the 10th Southeastern Seminar on Thermal Sci., New Orleans, 11-12 Apr. 1974 (NASA-TM-X-71538; E-7945) Avail: NTIS HC \$4.25 CSCL 20M

The feasibility of converting biomass to portable fuels is studied. Since plants synthesize biomass from H₂O and CO₂ with the help of solar energy, the conversion methods of pyrolysis, anaerobic fermentation, and hydrogenation are considered. Cost reduction methods and cost effectiveness are emphasized. G.G.

(COO-8326-27) **PROSPECTS OF PHOTOSYNTHETIC ENERGY PRODUCTION.** Kok, B. (Martha Marietta Labs., Baltimore, Md. (USA)). 1974. 10p. (CONF-740213-4). Dep. 24715 \$4.00.

From 14th meeting of The American Association for the Advancement of Science; San Francisco, California, USA (25 Feb 1974).

The relevant aspects of photosynthesis are reviewed, the prospects for expanded exploitation of natural solar conversion systems are evaluated, and some avenues for needed research are suggested. The cheapest, largest, and most successful solar energy conversion system available is photosynthesis. Photosynthesis is not an efficient energy source. One approach examined was the search for increased yield of combustibles (e.g., woody plants) and another was the interference with photosynthetic processes so that combustible gases like hydrogen or methane were produced. (MCW)

Gunter, J.D. Univ. of Oklahoma, Dept. of Geography, Norman, OK 73069

Jameson, W.C.

Recycling and re-use: The future of solid waste. Council of Planning Librarians. Exchange Bibliography 407, May 1973. 21 pp.

No abs., no refs., from Text & SS.

WASTE RECYCLING: SOLID WASTE DISPOSAL: COMPOSTING: ECONOMICS: POWER GENERATION: BIBLIOGRAPHIES.

A selected list of recently published works on various aspects of recycling is provided. It is categorized to reflect the types of material being published and it indicates the state of the art. Specific topics include techniques, economics, composting, glass, paper, plastics, abandoned automobiles, and waste as an energy source.

**N74-16674# RAND Corp., Santa Monica, Calif.
FUEL FROM ORGANIC MATTER: POSSIBILITIES FOR THE
STATE OF CALIFORNIA**

Doris J. Dugas Oct. 1973 19 p refs
(P-5107) Avail: NTIS HC \$3.00

The amounts of organic material that might be made available for energy purposes in the State of California, its potential fuel value, and the estimated cost are investigated. Sources of organic material that are considered are: (1) crops grown specifically for energy, (2) natural forests, and (3) wastes from the urban, agricultural, and industrial sectors. Preliminary results indicate that about 19 percent of California's gas supply could be derived from organic sources.

Author

**N74-15478# RAND Corp., Santa Monica, Calif.
FUEL FROM ORGANIC MATTER**

Doris J. Dugas Oct. 1973 25 p refs
(P-5100) Avail: NTIS HC \$3.25

It has been suggested frequently that the solar energy stored in green plants and organic wastes could be tapped to provide an alternative to the dwindling resources of fossil fuels. The advantage would be a fuel source that is renewable and available in our own time. This paper investigates the amounts of energy that might be made available from organic sources, the approximate cost of producing it and converting it to a convenient fuel, and some of the implications of a large-scale agro-energy industry. The discussion refers primarily to the United States, but the ideas could be adapted to other areas of the world.

Author

**FEEDLOT MANURE AND OTHER
AGRICULTURAL WASTES AS
MATERIAL AND ENERGY RESOURCES—1. IN-
TRODUCTION AND LITERATURE REVIEW.** This
report presents an introduction to the problem, a review
of present feedlot waste management methods and a
review of the available technology which may be
applicable to the processing of manure. It is believed
that the chemical processing of manure is an attractive
alternative to present feedlot waste management prac-
tices. The resulting products of processing agricultural
wastes can potentially be valuable assets to the develop-
ment of rural areas.

Walawender, W.P.; Fan, L.T. *Kans State Univ. Inst
Syst Des Optimization, Rep n 36 Apr 1972, 17 p.*

Walawender, W.P.

Kansas State Univ. of Agriculture and
Applied Science, Dept. of Mechanical
Engineering, Manhattan, KS 66508

Fan, L.T.

Engler, C.R.
Erickson, L.E.

**Feedlot manure and other agricultural wastes as future material
and energy resources: III. Economic evaluations.**

Kansas State University of Agriculture and Applied Science,
Manhattan. Institute for Systems Design and Optimization.
Report 46, July 1, 1973. 27 pp.

Abs., illus., refs., from AA.

Also in: Contribution No. 33 from Kansas Agricultural Experiment
Station, Dept. of Chemical Engineering, Manhattan.
See also: PA Citation No. 74-01390.

**AGRICULTURAL WASTES: FEEDLOT WASTES: ECONOMICS:
MANUFACTURED GAS: OILS: WASTE RECYCLING:**
energy resources.

An economic analysis of 3 potential processing schemes for
the conversion of feedlot wastes to useful products is presented.
The processes include liquefaction to oil, gasification to synthesis
gas, and hydrogasification to methane. Processing costs, on a
per ton of wet manure feed basis, were \$4.27, \$1.53, and \$9.41,
respectively. These costs include credit only for the sale of the
major product at approximately current prices. Capital investment
and the break-even sales price for the major product are presented.
The synthesis gas process was strongly favored; however, markets
for the product require further consideration.

**CATTLE MANURE TO PIPELINE GAS: A PROCESS
STUDY.** Feldmann, H. F. (Pittsburgh Energy Research Center);
Kiang, K. D.; Wen, C. Y.; Yavorsky, P. M. *Mech. Eng.* 95: No.
10, 36-41 (Oct 1973).

The feasibility of supplementing the dwindling supplies of natural
gas by the conversion of organic solid wastes to pipeline gas is ex-
amined. Not only does the disposal of these wastes constitute a
major environmental problem and expense, they are the only re-
newable resource and their utilization will become more important
as the natural resources become more scarce. A process is given
for converting cattle manure to pipeline gas by direct hydrogasifi-
cation. Economics of conversion is examined for two plant sizes,
one for 690,000 lb/h of manure containing 30 percent moisture, and
another of one-half this capacity. Gas prices, when averaged over
a 20-yr plant life, are 41 cents/10⁶ Btu for the large plant, and 67
cents/10⁶ Btu for the smaller unit. These economics together with
the economics of collecting and transporting the cattle manure, as
well as the value assigned to environmental protection, will deter-
mine how widely this technology can be applied. (MCW)

+++ "Clean Fluid Fuels From
Coal and Wastes" is the title
of an article available without
charge as "OP-149-73" from the
Publications Distribution Sec-
tion, Bureau of Mines, 4800
Forbes Ave., Pittsburgh, Pa.
15213.

PB-231 149/6WE PC54.75/MF\$1.45

The two-day conference addressed itself to the question of biological conversion of waste and feedlot materials to methane. The specific objectives of the conference were: to exchange recent research information between engineers and scientists on research accomplishments and problems related to bioconversion studies; to contribute to the long-range planning of the funding agencies and research workers in the field; to provide improved communications between the research community and the users' groups; to identify the processes and technology important to the production of methane from waste and feed lot materials; to identify the important economic factors associated with bioconversion processes. These proceedings consist of the summary statements provided by each principal speaker at the conference, together with a transcript of essentially all of the tape-recorded question-and-answer period.

Kenahan, C.B.

USBM, Office of the Assistant
Director-Metallurgy, 18th and C Sts.,
Wash., DC 20240

Kaplan, R.S.

Dunham, J.T.

Linnehan, D.G.

Bureau of Mines research programs on recycling and disposal of mineral, metal, and energy-based wastes.

U.S. Bureau of Mines. Information Circular 8595, 1973. 58 pp.

Abs., illus., numerous refs., from AA.

SCRAP METALS : MINING WASTES : INDUSTRIAL WASTES :
MUNICIPAL WASTES : SOLID WASTE DISPOSAL : WASTE
RECYCLING : FEDERAL AGENCIES : USBM.

The USBM research on recycling, reuse, and disposal of mineral, metal, and energy-based wastes is summarized. The USBM waste recycling and disposal program is directed toward the following 4 main areas of research and development: extraction of mineral, metal, and energy values from urban refuse; upgrading and recycling of automotive and related scrap; recovery, utilization, and stabilization of mine and mill processing wastes; and recovery and reuse of values from industrial waste products.

AIChE Symposium Series, v.69, no.133

1973

FOREST PRODUCTS AND THE ENVIRONMENT. Walter S.
Kaghan, ed. (Contains papers presented at the
Seventy-third National Meeting of the AIChE in
Minneapolis in Aug. 1972).

New techniques in the pyrolysis of
solid wastes. p.56-

Anon.

Solid waste management in the Denver region: Recycling,
resource recovery, disposal, regional management, siting,
alternatives, program, strategy.
Government Reports Announcements, 73(12): 154, June 25, 1973.

Abs. only, from AA, 1.

Contract: HUD HUD-H-1392.

Also in: Denver Regional Council of Governments, Colo. Final
Report DRCOG-72-018, Aug. 1972. 233 pp.
(Ref. order No. PB-218 992/6).

SOLID WASTE DISPOSAL : WASTE MANAGEMENT :
LANDFILLS : WASTE RECYCLING : COLORADO : abstract
only : Denver.

A proposed 20-yr regional program for solid waste management in the Denver region and implementation strategy and recommendations for carrying out the program are presented. Also included are a regional perspective, the urban system concept, description of the existing solid waste management situation, management responsibilities, criteria, assumptions and uncertainties, the 6 technical and 5 management alternative concepts developed for consideration, and an evaluation of those concepts from which the program was derived. The program includes proposed short-range activities for 1971-75 and a long-range program to achieve maximum recycling of energy and resource recovery, with minimum environmental pollution and landfill use by 1990 or earlier.

TITLE: Fuel from Organic Matter

AUTHOR: Dugas, D.J.

CORPORATE AUTHOR: Rand Corp.

ADDRESS: Santa Monica, CA 90406

PUBLICATION DESCRIPTION: Paper No. P-5100, 26 p.,
31 ref.

PUBLICATION DATE: 1973, October

ABSTRACT: The technical and economic aspects of tapping solar energy stored in plants and organic wastes to provide an alternative to the dwindling resources of fossil fuels are investigated. The amounts of energy that might be derived from conventional crops, trees, and algae are compared, as well as the costs of producing such energy and converting it to fuel. Three conversion methods are described: anaerobic bacterial fermentation which forms methane, yeast fermentation (ethyl alcohol), and pyrolysis (fuel oil). Some of the implications of a large-scale agro-energy industry are also examined. Conclusions are that the 300 million acres of uncultivated cropland and woodland in the U.S. could produce enough vegetation to provide more than half the current gas demand (based on 60% efficiency). Organic wastes, when converted to methane, would amount to about 10% of the annual gas demand. While fuel produced from crops is not presently economically competitive with oil and natural gas, it may become more attractive as petroleum resources are depleted. (PES)
AVAILABILITY: Rand Corp., Publications Dept.
(\$1.00)

Franklin, W.E.

Midwest Research Inst., 425 Volker Blvd.,
Kansas City, MO 64110

Bendersky, D.
Shannon, L.J.
Park, W.R.

CN-140,020

Resource recovery: The state of technology.

Government Reports Announcements, 73(12): 144, June 25, 1973.

Abs. only, from AA, 1.

(Ref. order No. PB-214 149/7).

MUNICIPAL WASTES : SOLID WASTE TREATMENT :

WASTE RECYCLING : abstract only : technology assessment.

An assessment of technology applicable to resource recovery from mixed municipal solid wastes is presented. Basic technical and economic data were gathered and compiled on a total of 40 existing and emerging resource recovery systems. The information was gathered through questionnaires sent to developers of each system, published and unpublished literature, personal communications, and selected site visits. An analysis was conducted of the technical and economic aspects of resource recovery systems that are ready for demonstration or are commercial plants. Included are systems for energy recovery, materials recovery, pyrolysis, composting, and chemical conversion.

Franklin, W.E.

Midwest Research Inst., 425 Volker Blvd.,
Kansas City, MO 64110

Bendersky, D.
Shannon, L.J.
Park, W.R.

Resource recovery: Catalogue of processes.

Government Reports Announcements, 73(12): 144, June 25, 1973.

Abs. only, AA, 1.

(Ref. order No. PB-214 148/9).

MUNICIPAL WASTES : SOLID WASTE TREATMENT : WASTE
RECYCLING : DIRECTORIES : abstract only : process directory.

A compilation is presented of basic data on 40 U.S. and foreign processes designed to recover resources from mixed municipal solid wastes. Processes are classified under energy recovery, materials recovery, pyrolysis, compost, and chemical. Technical, economic, and general information are given for each process when available. Included are the name and location of developer; status of development; input and output capacities; capital, operating, and net costs; revenues; process description; and sources of information.

Hydrogasification of cattle manure to pipeline gas

Kiang, K.D., et al., ACS Div. Fuel Chem. Proc., 18, (1), 18-23, (April 1973). 9 pp. The gas quality and yield that can be generated by direct hydrogasification of dried cattle manure was investigated by the U.S. Bureau of Mines at its Pittsburgh Energy Research Centre, following a feasibility study which established that the process was capable of providing solid wastes disposal and pipeline quality gas production at prices lower than supplementary gas from other sources.

CONVERSION OF MANURE TO OIL BY HYDROTREATING. Experimental study is reported which aimed at improvement of the process for manufacturing oil from organic waste. A method for hydrotreating organic wastes using synthesis gas and a combination of cobalt molybdate-sodium carbonate catalyst is presented. The proposed process requires no process water and results in the effective hydrogenation and decarboxylation of organic wastes without a significant consumption of hydrogen. Bovine manure is hydrogenated and liquefied by hydrogen or synthesis gas (equal amounts of hydrogen and carbon monoxide) at temperatures of 330 to 425°C and operating pressures of 1500 to 3000 psi in the presence of a recycle manure oil. Synthesis gas can be used in place of hydrogen to reduce hydrogen consumption without adverse effects. 3 refs.

Fu, Yuan C. Pittsburgh Energy Res. Cent., Pa. Illig. Eugene G.; Mellin, Sol J. *Am. Chem. Soc. Div. Fuel Chem. Prepr.* v 18 n 4 for Meet Aug 26-31 1973 p 153-163.

371

1973

THOMAS R. SCHNEIDER, National Center for Energy Management and Power, University of Pennsylvania, Philadelphia, Pennsylvania 19104, U.S.A.

Efficiency of photosynthesis as a solar energy converter: *Energy Conversion* 13, 77-84 (1973).

Summary—The efficiency of the conversion of solar energy into chemical energy in the form of plant material through photosynthesis is discussed. A theoretical upper bound of 11 per cent is obtained. Inclusion of losses resulting from other aspects of plant biology reduces the conversion efficiency to 5-6 per cent in practice. Record daily plant growth rates confirm this figure. This is the conversion efficiency of sunlight reaching the plant; efficiencies based on monochromatic light of optimal wavelengths can yield higher efficiencies, but their use with respect to the problem under consideration is inappropriate. Once converted into organic plant material this stored energy can be released as thermal energy or converted to another fuel such as a substitute natural gas.

Key words: Efficiency photosynthesis solar energy productivity
energy crops yield

FUEL GAS FROM ORGANIC WASTES.

D.L. Klass and S. Ghosh.
Chemtech, Nov. 1973, p.689-698.

Tells how solid wastes can be combined to make substitute natural gas.... and under some circumstances, a net profit.

CONVERSION OF MUNICIPAL WASTE TO A SUBSTITUTE FUEL. A single method and the considerations that apply to its development are presented. In order to evaluate the economic attractiveness of pyrolysis of solid wastes, costs were estimated for a plant producing gaseous fuel in a two-reactor system and for a plant using a single-reactor system. The economics are quite similar and the values for the two systems are provided. Based on the analysis made, it may be concluded that pyrolysis of refuse is economically attractive and could produce a fuel gas at an attractive price in today's market. 12 refs.

Rallie, Richard C. West Va Univ. Morgantown; Albert, Seymour. *Public Works* v 104 n 8 Aug 1973 p 76-79, 98.

TITLE: Technology for the Conversion of Solar Energy to Fuel Gas, Quarterly Report (First Quarter of 1973)
CORPORATE AUTHOR: University of Pennsylvania, National Center for Energy Management and Power

ADDRESS: Philadelphia, PA 19104
PUBLICATION DESCRIPTION: Report No. NSP/RANN/SE/G227976/73/1
PUBLICATION DATE: 1973, April 30
SPONSOR: National Science Foundation, RANN Program
ABSTRACT: This report covers research conducted during the first quarter of 1973, on the technology for the conversion of solar energy to fuel gas.-----Emphasis during this quarter has been based on the need to improve digester technology. Consequently, the development of increased laboratory-scale digester capacity has been stressed.-----The research program-----during this time period, has resulted in the establishment of sufficiently active and stably operating digester cultures to allow initiation of the experimental effort. The primary direction of this effort will be toward the achievement of two-stage digestion. (Auth. Summary modified)

TITLE: Biological Conversion of Organic Refuse to Methane, Semi-Annual Progress Report (July 1, 1973 to December 31, 1973)
AUTHOR: Pfeffer, J.T.; Liebman, J.C.
CORPORATE AUTHOR: University of Illinois at Urbana-Champaign, Dept. of Civil Engineering
ADDRESS: Urbana, IL 61801
PUBLICATION DESCRIPTION: Report No. NSP/RANN/SE/GI3191/PB73/4, UIU-ENG-73-2022, 95 p.

PUBLICATION DATE: 1973, December
SPONSOR: National Science Foundation, RANN Program
ABSTRACT: Urban solid wastes contain significant quantities of energy that can be reclaimed. Biological conversion of the organic refuse to methane by anaerobic fermentation is one mechanism by which this energy can be reclaimed. This report contains the results of an investigation of refuse fermentation of a thermophilic operating temperature of 60 degrees C. Results of dewatering of the fermenter residue by vacuum filtration and centrifugation are presented. A mathematical simulator of the fermentation process and vacuum filtration process has been constructed. Results from the simulator runs are presented. (Auth)

IS PIPELINE GAS FROM CATTLE MANURE A VIABLE FUEL? Elec. Light Power, E/G Ed.; 51: No. 23, 31-33(Dec 1973).
 A process used in which hydrogen was reacted with cow manure to determine the distribution and yield of hydrogasification products was evaluated. It was concluded that, for reasonably large plants, the gas would be cheaper than any other fuel source except natural gas at present prices. Manure and hydrogen are fed into a hydrogasification reactor, with an operating pressure about 1,000 psig. Because high pressure favors methane production, lowers the gas purification investment, and reduces the cost of compressor equipment to discharge the gas into the pipeline. The process is exothermic and any heat in excess of that required by the process can be used for steam production. Energy for the plant steam requirement is realized from the burning of char produced in the hydrogasifier. The cow manure was selected as a logical feedstock because of its chemical suitability and feedlots containing upwards of 50,000 head of cattle sanctioned reasonable-sized gas-production plants to be built nearby, eliminating transportation fees. (MCW)

Singh, Ram Bux
 Building a bio-gas plant.
 Compost Science, Emmaus, Pa., 13(2): 12-16, March-April 1972.
 No abs., illus., no refs., from Text & SS.
LIVESTOCK WASTES : WASTE RECYCLING : GASES : WASTE DISPOSAL
PLANTS : INDIA : bio-gas plants.

Construction and operation plans are presented for 5 types of bio-gas plants used in India: single-stage, double-chamber, small-scale plant; 2-stage digester; large single-stage digester; single-stage multiple digester; and vegetable waste digester. Four of the plants are designed to run on livestock wastes and one uses vegetable wastes.

1972

N74-18815 #

USBM, Wash., DC
Anderson, Larry L.
Energy potential from organic wastes: A review of the quantities and sources.

U.S. Bureau of Mines. Washington, D.C. Information Circular No. 8549, 19 pages, 1972.

Abs., illus., refs., from AA & Text

ORGANIC WASTES : WASTE REUSE : FUELS : energy potential.

Enormous quantities of organic wastes are produced each year in the U.S. The total amount is in excess of 2 billion tn and at least 880 million tn of this are moisture-and ash-free organic material.

representing a potential energy source of significant magnitude that is not being utilized. Methods for converting these wastes to convenient energy forms have been developed. Quantities and sources of moisture-and ash-free organic material contained in manure, urban refuse, industrial wastes, sewage solids, and agricultural wastes in the U.S. are itemized and evaluated. Estimates are presented for amounts of organic wastes collected or concentrated. The potential for fuel, either oil or gas, from both the total organic wastes generated and those collected or concentrated is also estimated: 1,098 million bbl of oil and 8.8 trillion ft³ of gas, and 170 million bbl of oil and 1.36 trillion ft³ of gas, respectively. The economic feasibility of converting organic wastes to oil or gas has not as yet been proven.

SOLID WASTE, NOW WASTED, COULD FUEL 6% OF US ENERGY;
CITIES, BURIED UNDER TRASH, INCAPABLE OF TACKLING
SOLUTION.

Energy Digest, v.11, no.1, Jan.17, 1972, p.1-4.

Schlesinger, M.D.
Sanner, W.S.

(all) USBM, Pittsburgh Energy Research
Center, PA

Walton, D.E.

Pyrolysis of waste materials from urban and rural sources.

Mineral Waste Utilization Symposium. Third. Unbound Papers. Preprints.
field in Chicago, IL, March 14-16, 1972. Sponsored by U.S. Bureau of
Mines and Illinois Institute of Technology Research Institute. [1972?].

Abs., figs., tables, data tables, refs. for various papers, SS.

gas, liquid and solid fuels by pyrolysis, and these fuels are clean when
burned. The process is thermally self-sufficient, and energy in the feed is
almost all recovered in the products. Recoveries for municipal refuse are
about 85% and for more selective feed stocks (scrap tires or plastics) they
are even higher. Moisture in the feed can affect product distribution by
reaction with hydrocarbons formed and by participation in the water gas
shift reaction. Typical waste materials pyrolyzed include scrap tires,
municipal refuse, wood waste, battery cases, sludge, and manure.
Properly designed units should vent no offensive products to the
environment. Residue sent to landfill would be sterile and a small fraction
of the original volume. The cost will be considerably less than for other
disposal methods.

Anon.

Solid waste: A new natural resource.

U.S. National Technical Information Service. Government Reports
Announcements, 72(19): 112-113, Oct 10, 1972.

Abs. only, from AA, 1.

(Ref. order No. PB-211 256)

REFUSE DISPOSAL : PYROLYSIS : FLUIDIZED BED PROCESSING :

WASTE RECLAMATION : MUNICIPAL REFUSE : abstract only : fuel gas
production.

An experimental program is described for converting municipal
refuse into fuel gas of high thermal efficiency using the fluidized bed
pyrolysis process. The process uses fluidized sand in the absence of
O₂ to allow the production of a fuel gas and char. A short description of
a pilot test is given.

Anon.

Fuel oil from organic wastes.

Chemical Processing. London, 18(3): 17-18, March 1972.

No abs., illus., no refs., from Text

COAL : ORGANIC WASTES : WASTE REUSE : FUEL OILS : pilot plants :
extraction processes.

The extraction of fuel oil from both coal and organic wastes such
as garbage is examined by reviewing the operation of 2 U.S. Bureau of
Mines pilot plants. The processes involved: convert lignite or garbage to
liquid fuel by employing carbon monoxide (CO) reactions, produced by
the introduction of CO in pure form or in a CO-rich synthesis gas.
Water and, unless naturally present, an alkali such as sodium
carbonate are added as catalysts.

N74-18815# Bureau of Mines, Washington, D.C.

ENERGY POTENTIAL FROM ORGANIC WASTES : A
REVIEW OF THE QUANTITIES AND SOURCES

Larry L. Anderson 1972 19 p refs.

(BM-IC-8549) Avail: SOD HC \$3.30

The quantities and sources of moisture- and ash-free organic
material contained in manure, urban refuse, industrial wastes,
sewage solids, and agricultural wastes in the United States are
itemized and evaluated. Furthermore, estimates are presented
for amounts of organic wastes collected or concentrated. The
potential for fuel, either oil or gas, from both the total organic
wastes generated and those collected or concentrated is also
estimated.

Author

373

(CONF-721112-10) SUBSTITUTE NATURAL GAS FROM ORGANIC MATERIALS. Schneider, T. R. (Pennsylvania Univ., Philadelphia (USA)). National Center for Energy Management and Power). 1972. 34p.
From American Society of Mechanical Engineers winter meeting; New York, New York, USA (26 Nov 1972).

The process of converting organic materials to methane via anaerobic fermentation appears to be both technically and economically feasible for large-scale use in converting the organic component of solid waste, both municipal and agricultural, to methane. Methane is an easily transported fuel and the major component of natural gas. The conversion of solar energy to plant material through photosynthesis and the conversion of organic plant material to methane is discussed. The growth of an energy crop as a feedstock for the manufacture of methane rests on development of a highly productive and inexpensive crop. Since photosynthesis and crop growth is not a very efficient energy conversion system, large areas would be required to fill a significant portion of the current gas demand. A theoretical upper bound on the efficiency of the conversion of solar energy into chemical energy in the form of plant material of 11% is obtained. Losses resulting from other aspects of plant biology reduces this efficiency to 5% to 6% in practice. Record daily plant growth rates confirm this figure. Factors which limit annual crop yields to levels below the value of the projected daily yields are evaluated. The above figures define the conversion efficiency of sunlight reaching the plant; efficiencies based on monochromatic light of optimal wavelength are yield higher efficiencies, but their use with respect to the problem under consideration is inappropriate. (auth)

ENERGY RECOVERY FROM WASTES.

Solid Wastes Management Series (SM-36d.i).
1972, D.C., EPA.

FUEL FROM WASTES: A MINOR ENERGY SOURCE.

T.H. Maugh II.
Science, v.178, Nov.10,1972, p.599-602.

Substitute natural gas from organic materials

Schneider, T.R., ASME Paper 72-WA/Ener-7 presented at the Winter Annual Meeting of the ASME, New York, (28-30 Nov. 1972). 12 pp. Available from ASME, 345 E. 47th St., New York, N.Y. 10017. Price \$3, \$1 for ASME Members. The process of converting organic materials to methane via anaerobic fermentation appears both technically and economically feasible for large-scale use in converting the organic component of solid waste, both municipal and agricultural, to methane. The anaerobic fermentation of 2 billion tons of dry organic material would suffice to meet the total present gas demand. The total annual production of organic wastes in the U.S. (domestic or urban solid waste, industrial wastes, crop residues, and animal wastes) may amount to 25-40% of the quantity required. A preliminary economic evaluation indicates that the cost of methane produced by digesting municipal wastes will be competitive with the alternative gas sources.

Clean fluid fuels from coal and wastes

Forney, A.J., and Haynes, W.P., ASME Paper 72-WA/A PC-3 presented at the Winter Annual Meeting of the American Society of Mechanical Engineers, New York, (28-30 Nov. 1972). 3 pp. Available from ASME, 345 E. 47th St., New York, N.Y. 10017. Price \$3, \$1 for ASME Members. There are many processes under development to help at least partially replenish our fast-fading supplies of natural gas and oil with new supplies of clean fuel. A brief review covers possible processes for converting coal to high-Btu gas, coal to low-Btu gas, coal to oil, wastes to gas, and wastes to oil, and for refining and hydrosulphurizing coal. A more vigorous effort in research and development, requiring greater expenditures of both money and manpower, will determine the direction needed and the more desirable processes.

Kenahan, Charles B.

Flint, Einar P.

Bureau of Mines research programs on recycling and disposal of mineral, metal, and energy-based solid wastes.

U.S. Bureau of Mines. Washington, D.C. Information Circular No. 8529, 59 pages, 1971.

Abs., illus., numerous refs., from AA

SOLID WASTE DISPOSAL : MINERALS : METALS : WASTE RECYCLING : INDUSTRIAL WASTES : USBM summary of research : energy-based solid wastes.

A summary of research on utilization and disposal of solid wastes is presented, accompanied by an extensive bibliography of related publications. The bureau's Solid Waste and Materials Recycling Program is directed towards 4 main ideas of research, development, and demonstration: extraction of mineral, metal, and energy values from urban refuse; upgrading and recycling of automotive and related ferrous and nonferrous scrap; utilization and reuse of values from industrial and smelter wastes; and recovery and reuse of values from industrial waste products. A contract and grant program that supplements the in-house research and aids in the training of manpower in management of these solid wastes is also discussed.

G. E. Johnson et al., "The Production of Methane by the Anaerobic Decomposition of Garbage and Waste Materials," Pittsburgh Energy Research Center, Bureau of Mines, USDI, presented at the 163d National Meeting of the American Chemical Society, Boston, Mass., Apr. 9-14, 1972.

1971

A POTENTIAL LARGE SCALE PLASMA PROCESS: SYNTHESIS OF INEXPENSIVE HYDROGEN BY USING A THERMONUCLEAR DEVICE TO VAPORIZE WASTE ORGANIC MATERIALS.

D.R. Safrany.

Chem. Eng. Sym. Ser., v.67, no.112, 1971, p.103-8.

Solar energy is stored as carbohydrates since these are produced via photosynthesis. This energy could be used to lower the cost of fixing nitrogen by the Haber process, by perhaps an order of magnitude, if the carbohydrates could be converted inexpensively to hydrogen and carbon monoxide. This might be accomplished by vaporizing with a thermonuclear device, and thus driving to thermodynamic equilibrium, large masses of organic waste materials, for example, sewage, lignin, etc. By using a contained nuclear explosion, hydrogen might be produced for considerably less than 1¢ and ammonia for 1/4¢/lb.

1971

FB-211 256
West Virginia Univ., Morgantown, Dept. of
Chemical Engineering.
SOLID WASTE: A NEW NATURAL
RESOURCE.
May 71, 18p

Descriptions: (*Refuse disposal, *Fluidized bed processing), (*Waste disposal, Fluidized bed processing), (*Pyrolysis, Waste disposal), (*Manufactured gas, Waste disposal), Sand, Detergents, Cellulose, Fuchs, Performance evaluation, Utilization, Identification, *Solid waste disposal, *Pyrolysis incineration.

74V17294 1971 ISS:00 FD899.P4N38 629.255 LC-74-614707 SOD EP
2.10:15080DB003/71

CONVERSION OF CRANKCASE ♦♦ WASTE ♦♦, OIL INTO USEFUL
PRODUCTS. ♦♦

AUTHORS: SOLFRED MAIZUS AND KENNETH URBHART. PREPARED FOR THE
WATER QUALITY OFFICE, ENVIRONMENTAL PROTECTION AGENCY.
NATIONAL OIL RECOVERY CORPORATION.

ENVIRONMENTAL PROTECTION AGENCY, WATER QUALITY OFFICE; FOR SALE BY
THE SUPT. OF DOCS., U.S. GOVT. PRINT. OFF., WASHINGTON VII, 87 P.
ILLUS. 29 CM.

WATER POLLUTION CONTROL RESEARCH SERIES \$1.00 "15080 DB0 03/71."

LC:PETROLEUM ♦♦ WASTE. ♦♦

ADDED:MAIZUS, SOLFRED. URBHART, KENNETH. UNITED STATES.

ENVIRONMENTAL PROTECTION AGENCY, WATER QUALITY OFFICE.

MAIN-CORP TRACE-SERS♦CORP♦TITL♦AUTH♦ CATLG BY-LC

H. P. Feldmann, "Pipeline Gas from Solid Wastes," paper presented at
AIChE 69th Annual Meeting, Cincinnati, Ohio, 1971.

CN-129, 304

PC-203 609
Bureau of Mines, Washington, D.C.
PC33.00 MF30.95
CONVERTING ORGANIC WASTES TO OIL: A
REPLENISHABLE ENERGY SOURCE.

Report of investigations,
Herbert R. Appell, Y. C. Fu, Sam Friedman, P. M.
Yavonky, and Irving Wender. 1971. 24p. BM-R1-
7560

Descriptors: (*Synthetic oils, Production en-
gineering), (*Cellulose, Synthetic oils), (*Waste
disposal, *Materials recovery), Hydrolysis, Car-
bon monoxide, Catalysts, Chemical engineering,
Water, Alkaline earth compounds, Spectroscopic
analysis.

Identifiers: *Solid waste disposal, *Waste
recycling.

The Bureau of Mines is experimentally converting
cellulose, the chief constituent of organic solid
waste, to a low-sulfur oil. All types of cellulosic
wastes, including urban refuse, agricultural
wastes, sewage sludge, wood, lignin, and bovine
manure, have been converted to oil by reaction
with carbon monoxide and water at temperatures
of 350 to 400C and pressures near 4,000 psig. and
in the presence of various catalysts and solvents.
Cellulose conversions of 90 percent and better
(corresponding to oil yields of 40 to 50 percent)
have been obtained. A continuous reactor for use
in continuous conditions up to 300C and 5,000 psig
has been operated successfully. Using sucrose as a

feedstock, operation in this system has permitted a
simplified and preliminary chemical study of the
conversing process. Oil yields of over 30 percent
have been obtained with this unit.

CATALYTIC SYNTHESIS GAS MANUFACTURE.
Waller, R. J. (to Clavens Machine Co.). 99-Patent 3,750,877.
13 Sep 1973. Filed date 8 May 1970. 14p.

A process is presented for producing synthetic gas that com-
prises contacting an organic feed material, containing hydrogen
and at least 10 weight percent oxygen and containing less than
five weight percent sulfur, with steam in the presence of an
alkali metal carbonate catalyst at an elevated temperature.
Preferably the feed material is solid waste material, more
preferably solid municipal waste. (Official Gazette)

POWER FROM SOLAR ENERGY VIA ALGAE PRODUCED METHANE.

C.G. Golueke and W.J. Oswald.

Solar Energy, v.7, no.3, 1963, p.86-92.

1974

CLOSING THE REFUSE POWER CYCLE. Singer, J. G.; Mullen, J. F. Combustion; 45: No. 8, 20-30 (Feb 1974). From ASME-IEEE joint power generation conference, New Orleans, LA (16 Sep 1973).

Refuse burning may be applied to prepared municipal waste as a secondary fuel in the steam-generation process. A comparison is made of the West German practice of refuse burning on grates and the pneumatic-injection system installed at the Meramec Station of the Union Electric Company of St. Louis. Some types of fossil-fuel-fired steam generators are not as adaptable as others for refuse disposal. Steam generators operating essentially as base load units may be more desirable for burning solid waste than those operated at partial loads. The capital cost for conversion may not be attractive to a utility if the operation involves only small quantities of refuse. The location of the power plant may not always permit economical application of the process. (MCW)

Environment, v.16, no.2, Mar.1974.

POWER FROM TRASH

William C. Kasper

Solid wastes could make a modest but important contribution to energy supplies and be transformed from a problem to an asset. Direct burning and manufacture of fuel from wastes are discussed.

1974

34

377

1974

LET'S BURN SOME RUBBER. Elec. Light Power, E/G Ed.; 53: No. 1, 36-37 (Jan 1974).

A Lucas furnace system, a cyclonic furnace, may have applications in the utilities as a source of heat energy and municipal waste disposal. Some incinerators are operating in England, Australia, and at the Goodyear Tire and Rubber Company at Jackson, Michigan. A sludge burning furnace is being constructed in San Leandro, California. The furnace is essentially a vertical domed cylinder with a rotating hearth at the bottom and an array of air jets and burners around the furnace wall. There is complete oxidation minimizing smoke, particulates, and oil-gases. The process, using tires, is autothermic and the cyclone quickly builds temperatures to 2200°F. The furnace heat can produce ~100,000 lbs. steam/hr at 450°F as it consumes 600 tires/hr. The output is considered as only process steam, but its heat energy could be useful in multi-stage process systems. In this process, the tires may be fed whole, while previous methods have required shredding, etc. (MCW)

1974

WOOD FUELS THE DEVELOPING WORLD.

K. Openshaw.

New Scientist, Jan.31,1974, p.271-272.

Wood is a major source of fuel in many countries and as the price of oil rises, wood fuel will become more important.

ADVANCED TECHNIQUES FOR INCINERATION OF MUNICIPAL SOLID WASTES.

Jack DeMarco.

Amer. Inst. Chem. Engineers Symposium Ser., v.70, no.137, 1974, p.481-

Although communities have long used incineration in trying to cope with their solid waste problems, there has been a certain amount of dissatisfaction with the results of the process. Much of the dissatisfaction is well justified and, unfortunately, is still present, but the days of the belching smokestack are numbered. New standards at the local, State, and Federal level no longer allow for procrastination in improving our environment. The upper limits of good technology are now being set as implementation requirements.

The best technology currently available on emissions, control techniques, and incinerator maintenance and operation as they relate to air pollution control must be put into use without delay. In addition, new concepts must be demonstrated, proven effective, and then put into operation in our solid waste management activities. EPA is supporting two projects in its efforts to demonstrate advanced techniques for processing the ever-growing amounts of solid waste that are generated in our country.

(COO-3326-27) PROSPECTS OF PHOTOSYNTHETIC ENERGY PRODUCTION. Kok, B. (Martin Marietta Labs., Baltimore, Md. (USA)). 1974. 10p. (CONF-740213-4). Dep. NTIS \$4.00.

From 140th meeting of The American Association for the Advancement of Science; San Francisco, California, USA (25 Feb 1974).

The relevant aspects of photosynthesis are reviewed, the prospects for expanded exploitation of natural solar conversion systems are evaluated, and some avenues for needed research are suggested. The cheapest, largest, and most successful solar energy conversion system available is photosynthesis. Photosynthesis is not an efficient energy source. One approach examined was the search for increased yield of combustibles (e.g., woody plants) and another was the interference with photosynthetic processes so that combustible gases like hydrogen or methane were produced. (MCW)

MUNICIPAL REFUSE: A FUEL FOR ELECTRIC UTILITY BOILERS.

G.W. Sutterfield, D.L. Klumb and F.E. Wisely. Recent Advances in Air Pollution Control, AICHE Symposium Series, v.70, no.137, 1974, p.484-488.

Full-scale testing to determine the feasibility of burning suitably prepared refuse in existing pulverized coal-fired boilers has been underway by the City of St. Louis and Union Electric Company since April, 1972.

The potential benefits which can accrue to the metropolitan area as well as the ability include an environmentally acceptable means of solid waste disposal, conservation of irreplaceable natural resources, more effective control of land use, and, of course, electric power generation.

N74-21391# Esso Research and Engineering Co., Linden, N.J. COMBUSTION AND HEAT RECOVERY OF AIR FORCE WASTE PETROLEUM OILS AND LUBRICANTS Final Report.

Aug. - Dec. 1973

Martin Lieberman Feb. 1974 73 p refs (Contract F29601-73-C-0101; AF Proj. 683M) (AD-774563; AFWL-TR-73-244). Avail. NTIS CSCL 21/4

The primary objective of this study was to evaluate the technical feasibility of disposing of waste oils and contaminated fuels generated at Air Force bases by burning them with fuel oil and/or natural gas in a conventional boiler installation. Waste aviation piston-engine oil, synthetic turbine lubricant, hydraulic fluid, Stoddard solvent, crankcase oil, JP-4 jet fuel, and aviation gasoline were burned in No. 2, No. 6 fuel oils, and with natural gas carriers. The results of combustion tests, conducted for as long as 3 hours, indicated that the waste oils could be burned at as high as 5 percent by volume in the fuel oils without producing any significant air pollution or boiler corrosion problems. Each gallon of waste oil or contaminated fuel burned saves approximately a gallon of fuel oil. GRA

DISTRICT HEATING CAN ANSWER REFUSE DISPOSAL PROBLEM. Energy Int., 10: No. 10, 12-14(6-1)1973.

Incineration for the disposal of domestic and industrial wastes is coupled to district heating networks for the utilization of the energy generated. Problems for urban areas are the maintenance of a clean and tidy, healthy and enjoyable environment. The incineration of wastes combined with district heating facilities is discussed for several cities. Systems are advanced in Europe, and the systems in Nottingham and Coventry are discussed. The Japanese experience with waste disposal heat is explained. Stockholm's Ingdalen Incinerator plant is one of two serving the city. The operation of the systems in Mannheim, Germany, France, and the North America is described. (MCW)

Franklin, W.E.

Midwest Research Inst., 425 Volker Blvd.,
Kansas City, MO 64110

Bendersky, D.

Shannon, L.J.

Park, W.R.

CN-140, 020

Resource recovery: The state of technology.

Government Reports Announcements, 73(12): 144, June 25, 1973.

Abstr. only, from AA. 1.

(Ref. order No. PB-214 149/71).

MUNICIPAL WASTES: SOLID WASTE TREATMENT:

WASTE RECYCLING: abstract only: technology assessment.

An assessment of technology applicable to resource recovery from mixed municipal solid wastes is presented. Basic technical and economic data were gathered and compiled on a total of 40 existing and emerging resource recovery systems. The information was gathered through questionnaires sent to developers of each system, published and unpublished literature, personal communications, and selected site visits. An analysis was conducted of the technical and economic aspects of resource recovery systems that are ready for demonstration or are commercial plants. Included are systems for energy recovery, materials recovery, pyrolysis, composting, and chemical conversion.

Franklin, W.E.

Bendersky, D.

Shannon, L.J.

Park, W.R.

Midwest Research Inst., 425 Volker Blvd.,
Kansas City, MO 64110

Resource recovery: Catalogue of processes.

Government Reports Announcements, 73(12): 144, June 25, 1973.

Abstr. only, AA. 1.

(Ref. order No. PB-214 148/9).

MUNICIPAL WASTES: SOLID WASTE TREATMENT: WASTE RECYCLING: DIRECTORIES: abstract only: process directory.

A compilation is presented of basic data on 40 U.S. and foreign processes designed to recover resources from mixed municipal solid wastes. Processes are classified under energy recovery, materials recovery, pyrolysis, compost, and chemical. Technical, economic, and general information are given for each process when available. Included are the name and location of developer; status of development; input and output capacities; capital, operating, and net costs; revenues; process description; and sources of information.

Solid waste as a utility fuel. G.E. Dreifke, D.L. Khumb, J.D. Smith (Union Electric Co., St. Louis, Mo., USA).

Proceedings of the American Power Conference. Vol. 35, Chicago, Ill., USA, 8-10 May 1973 (Chicago, Ill., USA: Illinois Inst. Technol., 1973), p.1198-206. Full-scale testing to determine the feasibility of burning prepared refuse in an existing pulverized-coal-fired boiler has been under way by the City of St. Louis and Union Electric Company since April 1972. The raw municipal refuse collected by the City is milled to small particles, magnetic metals removed, and the remainder fired pneumatically to a 125-MW boiler unit. The potential benefits which can accrue to the metropolitan area as well as the utility include an environmentally acceptable means of solid-waste disposal, conservation of irreplaceable natural resources, more effective control of land use, and of course, electric power generation. (2 refs.)

(EPA-R-8-73-293) **WASTE AUTOMOTIVE LUBRICATING OIL AS A MUNICIPAL INCINERATOR FUEL.** Chanaky, S.; McCoy, B.; Surprenant, N. (Environmental Protection Agency, Washington, D. C. (USA). Office of Research and Development). Sep 1973. 70p. GPO \$1.05.

The technical, economic, and environmental impact of utilizing waste automotive lubricating oils to improve the municipal incineration combustion process was examined. Utilization of the heating value of waste oil in a municipal incinerator can help to alleviate the high level of combustible air pollutants and poor residue quality resulting from the firing of wet and/or low flu-value refuse. Laboratory analyses of selected physical properties of waste oil and a waste oil burner testing program were conducted to complement an information search program. The physical and chemical properties of waste oil were reviewed in relation to its suitability as a fuel oil. The auxiliary fuel heat flux requirements to offset the adverse effects of wet refuse were estimated utilizing a combustion model of a refuse bed. Various methods were evaluated for transferring this required heat flux to the refuse bed. Suggested designs for monitoring and control; and waste oil storage and feed systems were presented. The impact on air quality from the combustion of waste oil in a municipal incinerator was estimated. Three-month average ground level concentrations for lead were calculated and presented as concentration isopleths. Capital investment and operating costs were developed for auxiliary waste oil systems in conjunction with municipal incinerators. (64 references) (auth)

N74-18726J Union Electric Co., St. Louis, Mo.
RECYCLING SOLID WASTE FOR UTILITY FUEL AND RECOVERY OF OTHER RESOURCES

Earl K. Ditts and David L. Mum 1973 17 p refs Presented at 1973 Frontiers of Power Technol., Stillwater, Okla. Sponsored by City of St. Louis

Avail. NTIS HC \$4.00

Full scale prototype testing to determine the feasibility of processing municipal solid waste to produce supplementary fuel for electric utility boilers and to recover recyclable, non-combustible materials has been conducted. Operation of the prototype was satisfactory during the first year with the exception of milled solid waste mechanical handling problems. Crushed glass in the solid waste resulted in excessive wear and maintenance of solid waste pneumatic transport piping bends and elbows. Metals and oversize pieces of wood caused frequent stoppages of solid waste transport system mechanical feeding equipment. The mechanical handling problems were identified soon after the initial operation and it appeared clear that the material presented no other operating problems at the processing plant or in furnace combustion. Consequently, engineering design and purchase of a mechanical air separator (air classifier) was initiated to provide for the removal of glass, metals, and other unburnable materials. Author

ENERGY CONCEPTS FOR NEW ERA. Heat Eng.-1

46: No. 5, 65-80(1973).

The utilization of waste heat and waste fuel means increased efficiencies and a cleaner environment. Some developments for the reclamation of waste fuels and waste heat at Foster Wheeler Limited are discussed. Refuse-fired boilers that have bark-burning equipment as an integral part of the main furnace are described. Not only waste fuels from the forest industry may be applied, but also bagasse from sugar cane, pits from olives, coconut shells, and husks and chaff from milling of grain. The shop-assembled wood and fibrous fuel-fired boilers are described. Flue gases discharged to the atmosphere are being reclaimed and the use of by-products such as CO and refinery coke are being used as fuel for steam generators. Some currently employed heat recovery schemes and the selection of suitable equipment are reviewed. (MCW)

SOLID WASTE DISPOSAL: INCINERATION OR PYROLYSIS.

J.A. Fife.

Environmental Sci. & Tech., v.7, no.4, Apr.1973, p.308-312.

Combustion processes not only reduce volume and weight of municipal refuse, but could produce steam or electricity.

Goldrath, B. 108 Hobart Ave. San Mateo, CA 94402

Gas turbine key to solid waste disposal.

Diesel and Gas Turbine Progress, 39(8) 12-14, Aug 1973

No abs., illus., no refs., from Text.

SOLID WASTE DISPOSAL: ELECTRIC POWER PLANTS.

INTERNAL-COMBUSTION ENGINES. Combustion Power Co
EPA: gas turbines.

In the Spring of 1973, Combustion Power Company put into operation a pilot plant embodying the most advanced technology in the waste treatment field. The project was funded by EPA's Office of Research and Monitoring. The CPU-400 system was designed to recover energy and valuable materials economically from solid wastes in a pollution free manner. The system recovers energy from combustible material and converts it to usable power through a gas turbine powered electric generator. The full-scale version will produce about 5% of a community's electric power needs, besides providing a completely automated nonpolluting packaged plant for disposing of unsegregated municipal wastes. The economic aspects of this system are considered. Exhaust gas emission is discussed, and the major steps in the CPU-400 system are described.

TITLE: Solid Waste and Its Potential As A Utility Fuel

AUTHOR: Kasper, W.

CORPORATE AUTHOR: New York State Public Service Commission, Office of Economic Research
ADDRESS: 88 Holland Avenue, Albany, NY 12208
PUBLICATION DESCRIPTION: O.E.R. Report No. 18, 25 pages

PUBLICATION DATE: 1973, October 28

ABSTRACT: This report presents an overview of various processes which have been developed to dispose of solid wastes with emphasis on processes which are adaptable to usage by electric utilities. Various processes have been developed to use the heat potential of solid wastes. For the most part, these processes involve either the direct combustion of the organic portion of solid waste or the conversion of the organics into a liquid or gaseous fuel. The author contends that methods for the direct combustion of solid waste are technically feasible and economically viable at the present time. More advanced methods which convert solid waste to other types of fuel could prove more efficacious in the future, but their evaluation awaits the completion of large scale demonstration plants currently under construction. Also considered is the possibility of recycling most of the components in solid waste which though seemingly possible, still must be proven viable for large scale applications. (Auth)

AVAILABLE: Mrs. Georgianna Paluba, Central Librarian, NY State Public Service Commission, 88 Holland Ave., Albany, NY 12208

M74-19698# City of St. Louis, Mo.
ENERGY RECOVERY FROM WASTE: SOLID WASTE AS SUPPLEMENTARY FUEL IN POWER PLANT BOILERS
Interim Report

Robert A. Lowe 1973 29 p refs

(Grant EPA-S-802255)

(SW-38d.ii: IR-2) Avail: SOD HC \$0.40

The process of converting municipal solid waste into energy for power plant boilers is described. The process involves collecting the waste from residential areas, grinding the material, and air-classifying the shredded wastes to find the light combustible fraction. Magnetic metals are recovered from the heavier, mostly noncombustible, wastes. Other topics of discussion include: the processing system and its operation; boiler modification and operating experience; air pollution considerations; markets; and economics. K.M.M.

St. Louis City/Union Saint Louis, MO.

Electric Co.

Energy recovery from waste. A municipal-utility joint venture.
Government Reports Announcements, 73(3): 121, Feb. 10, 1973.

Abs. only, from AA, 1.

Grant: EPA G06-EC-00311.

Also in: U.S. Solid Waste Management Office. Publication EPA-SW-366.1, 1972, 20 pp.

(Ref. order No. PB-213 534/2).

**SOLID WASTE DISPOSAL : MUNICIPAL WASTES : FUELS :
BOILERS : POWER GENERATION : HEAT RECOVERY :
ELECTRIC POWER PLANTS :** abstract only.

The recovery of thermal energy by burning shredded residential solid waste as supplementary fuel in boiler furnaces is discussed. The process details, the processing facilities, the receiving and firing facilities, the test boiler, and the economics and applicability are examined.

Metcalf and
Eddy, Inc.

Statler Office Bldg., Boston, MA 02116

Generation of steam from solid wastes.

Government Reports Announcements, 73(5): 110, Mar. 10, 1973.

Abs. only, from AA, 1.

Contract: USPHS PHS-EC-00195.

Also in: U.S. Solid Waste Management Office. Report EPA-SW-490-72, 1972, 139 pp.

(Ref. order No. PB-214 168/1)

**SOLID WASTE DISPOSAL : MUNICIPAL REFUSE :
INCINERATORS : WASTE RECLAMATION : STEAM :
ECONOMICS :** MASSACHUSETTS : abstract only : Lynn.

TITLE: Energy Forests and Fuel Plantations

AUTHOR: Stego, G.C.; Kemp, C.C.

CORPORATE AUTHOR: InterTechnology Corp.

ADDRESS: P.O. Box 340, Warrenton, VA 22186

PUBLICATION DESCRIPTION: Chentech, 275-284, 23 references

PUBLICATION DATE: 1973, May

ABSTRACT: The environmental advantages of using agricultural plants or trees as fuel for a power plant are outlined. Theoretical calculations are made of possible various production per acre and the associated costs. The results indicate that fuel costs of about \$1 per million Btu might be achieved. (JMC)

1973

TITLE: Energy and Raw Material Potentials of Wood Residues in the Pacific Coast States - A Summary of a Preliminary Feasibility Investigation

AUTHOR: Pletovich, J.M.; Grantham, J.B.; Estep, L.A.; Tartov, R.; Adams, T.C.

CORPORATE AUTHOR: U.S. Dept. of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station

ADDRESS: Portland, OR

PUBLICATION DESCRIPTION: Interim Report, 16 p.

PUBLICATION DATE: 1973, May

ABSTRACT: About 16 million dry tons of wood and bark residue created annually by logging and manufacturing operations remain unused in the four Pacific Coast States. This material constitutes a sizable solid waste management problem for which improved solutions are being demanded. Solutions include use as a source of energy or of raw material for pulp and board products. A preliminary investigation of the feasibility of such uses revealed that the high cost of collecting and transporting logging residue severely limits its use potential. Mill residue, except for bark, is widely used for fuel and products, especially pulp chips and particleboard. Generating electricity from wood residue does not appear feasible in the Pacific Northwest--unless there is public absorption of a large portion of the wood-to-energy conversion costs. Means are suggested by which the public can share these costs. Use of wood residue for in-plant steam and power needs by the wood industry is more feasible. This is especially true for industries capable of using sound portions of logging residue for products and the bark, fines, and decayed material for fuel. Burning mill residue in combination with municipal refuse to generate power may be economical--provided the costs of using wood fuel are less than the costs incurred in alternative disposal methods. Positive selling values for chips for pulp and particleboard make these raw material uses more attractive than for generating energy. However, even these returns are generally not large enough to meet the high costs of delivering logging residue for use. Advances in equipment and methods through research and development appear to hold the key to increased residue use. Local feasibility evaluations must be made to measure tradeoffs between utilization costs and benefits. Benefits must include gains to the public, to identify the best residue management alternative in a given situation. (auth)

FUEL FROM CITY TRASH. Wilcox, D. Environ-

ment; 15: No. 7, 36-42(Sep 1973).

A project in St. Louis, Missouri using city refuse to supplement coal fuel in boiler furnaces that generate electricity is described. The project is sponsored by the city, the Union Electric Company, and the Federal Environmental Protection Agency. Four factors discussed are: the implication of the project for solid waste disposal and resource and energy recovery; the project's applicability on a nationwide scale; the economic aspects; and the environmental considerations. The St. Louis project does not offer a solution to the solid waste disposal, recycling, and the energy crisis. The burning of the garbage produces chlorine-containing emissions. The city plans to sell the magnetically separated ferrous metals, mostly scrap cans, to the nearby Granite City Steel Company, which will use this scrap to replace, on the order of 15 tons per day, iron ore in its blast furnaces. The refuse processing procedure is described. (MCW)

Waste disposal: the alternatives of combustion. R.S. Rochford.

J.D. Walker (Babcock & Wilcox Co., Lynchburg, Va., USA). *Energy Int. (USA)*, p.15-16 (Oct. 1973). Deals with municipal refuse which is burnt as a supplementary fuel in power station boilers. The requirements for incinerator design are discussed. (no refs.)

Gunter, J.D. Univ. of Oklahoma, Dept. of Geography, Norman, OK 73069

Jameson, W.C.

Recycling and re-use: The future of solid waste.

Council of Planning Librarians. Exchange Bibliography 407, May 1973, 21 pp.

No abs., no refs., from Text & SS.

WASTE RECYCLING : SOLID WASTE DISPOSAL : COMPOSTING : ECONOMICS : POWER GENERATION : BIBLIOGRAPHIES.

A selected list of recently published works on various aspects of recycling is provided. It is categorized to reflect the types of material being published and it indicates the state of the art. Specific topics include techniques, economics, composting, glass, paper, plastics, abandoned automobiles, and waste as an energy source.

Anon.

Solid waste management in the Denver region: Recycling, resource recovery, disposal, regional management, situation, alternatives, program, strategy.

Government Reports Announcements, 73(12): 154, June 25, 1973. Abs. only, from AA, 1.

Contract: HUD HUD-H-1392.

Also in: Denver Regional Council of Governments, Colo. Final Report DRCOG-72-018, Aug. 1972, 233 pp.

(Ref. order No. PB-218 992/6).

SOLID WASTE DISPOSAL : WASTE MANAGEMENT : LANDFILLS : WASTE RECYCLING : COLORADO : abstract only : Denver.

A proposed 20-yr regional program for solid waste management in the Denver region and implementation strategy and recommendations for carrying out the program are presented. Also included are a regional perspective, the urban system concept, description of the existing solid waste management situation, management responsibilities, criteria, assumptions and uncertainties, the 6 technical and 5 management alternative concepts developed for consideration, and an evaluation of those concepts from which the program was derived. The program includes proposed short-range activities for 1971-75 and a long-range program to achieve maximum recycling of energy and resource recovery, with minimum environmental pollution and landfill use by 1990 or earlier.

Horner & Shrifrin, 5200 Oakfield Ave., St. Louis, MO 63110

Solid waste as fuel for power plants.

Government Reports Announcements, 73(14): 153, July 25, 1973.

Abs. only, from AA, 1.

Grant: USPHS PHS-EC-00176.

Also in: U.S. Solid Waste Management Office. Final Report EPA-SW-36D-73, 1973, 158 pp.

(Ref. order No. PB-220 316/4).

SOLID WASTE DISPOSAL : FUELS : COMBUSTION : ELECTRIC POWER PLANTS : POLLUTION CONTROL EQUIPMENT : FEASIBILITY STUDIES : MISSOURI : abstract only.

The technical and economic feasibility of burning prepared municipal refuse as supplementary fuel in large suspension-fired utility boilers is determined. Consideration is given to the physical and chemical characteristics of raw refuse and refuse with certain components removed. Consideration was also given to the characteristics of the ash and residue resulting from the combustion of refuse and to the potential effects upon operation and maintenance of the components of the boiler units. The relative economics of the full-scale application of the process was also assessed, and an evaluation was made of the effects upon public health and air pollution control.

Stump, P.L.

Solid waste demonstration projects.

U.S. Solid Waste Management Office. Publication. SW-4p, 1972.

255 pp.

Sums., illus., refs. for various papers, from Preface & SS.

SOLID WASTE TREATMENT : REFUSE COLLECTION :

LANDFILLS : WASTE RECYCLING : FUELS : WASTE

MANAGEMENT : CONFERENCES : proceedings : Office of

Solid Waste Management Programs.

Papers are presented on management systems, collection and transport, processing, resource recovery, and ultimate disposal of solid waste. Specific projects examined sanitary landfill operations on abandoned strip mines, rural collection and disposal operations, fiber recovery through hydropulping, refuse milling for landfill disposal, the Kuka Shark collection vehicle, mechanized residential refuse collection, thermal reduction of solid waste, refuse as fuel for power plants, the container-train method of solid waste collection and disposal, problems affecting the recycling of selected secondary materials, ferrous solid waste, and solid waste management.

Anon.

U.S. company generates electricity from garbage.

Environment News. Edmonton, Canada. 2(4): 5-8, July 1972.

No abs., no refs., from Text & SS.

ELECTRIC POWER : FUELS : MUNICIPAL REFUSE : WASTE RECYCLING :

MISSOURI : Union Electric Co.

The use of solid waste for generation of electricity is considered, with emphasis on a project undertaken by the Meramac Plant of the Union Electric Company (Saint Louis, Missouri). Shredded municipal refuse is burned at the plant and used as a supplementary fuel in utility boiler furnaces. The refuse cannot be stored for more than a few days, so it must be burned as it is collected. The high cost of transport from collection points to the plant is also a problem.

TITLE: Generation of Steam From Solid Wastes
CORPORATE AUTHOR: Metcalf & Eddy, Inc.; City of
Lynn

ADDRESS: City of Lynn,
Massachusetts, City Hall, Lynn, MA 01901

PUBLICATION DESCRIPTION: Report no.

EPA-SW-69D-72, NTIS PB 218-166, 139 p.

PUBLICATION DATE: 1972

SPONSOR: U.S. Environmental Protection Agency,
Office of Solid Waste Management Programs

ABSTRACT: The economic feasibility of a refuse-fired waterwall incinerator that would supply steam to an industrial firm is investigated for a community looking for an acceptable solid waste disposal method. Several different combinations of grate type, equipment ownership, and equipment location are cost-compared in detail. Plant equipment components and manpower requirements are described. Other solid waste disposal alternatives are discussed. The City of Lynn concludes that a waterwall incinerator facility is the region's most feasible future solid waste disposal method. (auth)

AVAILABILITY: NTIS

Mullin, John R.

Incinerator-heating plant. Element in city planning.

Military Engineer. Journal of the Society of American Military Engineers. Washington, D.C., 64(422): 418-421, Nov.-Dec. 1972.

No abs., illus., no refs., from Text

INCINERATORS : HEATING SYSTEMS : MUNICIPAL REFUSE : REFUSE

DISPOSAL : FEDERAL GERMAN REPUBLIC : Frankfurt : incinerator-heating plant.

Incineration as a nonpolluting and conservationary method of disposing of refuse is discussed. The prime example being Frankfurt's (Germany) disposal plant where the refuse is compacted, incinerated, and sorted, to remove metals for recycling. The heat given off by incineration process is used for city heating and the land used for the plant is at a minimum to conserve land.

Solomon, Joan

The social redemption of pure garbage.

New York Academy of Sciences. Sciences, 12(6): 13-15, July-Aug. 1972.

No abs., illus., no refs., SS.

MUNICIPAL REFUSE : WASTE REUSE : FUELS : ELECTRIC POWER

PLANTS : INCINERATION : energy sources.

With technological advancement, municipal solid wastes could be efficiently converted into fuel and help solve the fuel shortage and pollution problems. An electric company feeds pulverized refuse directly into a power generating station normally fueled only by pulverized coal; 170 TPD could supply enough energy to run a 100 Mw plant. Other experiments in this field are discussed. Public opinion obstacles to such utilization, however, must be surmounted.

Spaite, Paul W.

Miller, Carlton K.

Power boilers: The ultimate solution for solid waste?

Power Engineering. Chicago, 76(3): 54-55, March 1972.

Sums., illus., no refs., from Text & SS.

WASTE REUSE : SOLID WASTE DISPOSAL : MUNICIPAL REFUSE : HEAT

RECOVERY : FUELS : POWER PLANTS.

About 360 million TYP of municipal refuse is generated in the U.S. A.M. Kinney, Incorporated, developed a new way to recover the heat value of such refuse. The thermal recovery system is described which processes solid wastes by converting combustibles to solid homogenous fuel for power boilers either in industrial service or for electric power generation. With add-on features it can separate and classify noncombustibles for recycling. The recovery unit described can process 1,000 TPD of municipal refuse. Economic considerations are also given for the various refuse disposal methods.

A/BUCKHAM, J. A.; B/DICKEY, B. R.; C/KELLER, F. R.; D/SOWARDS, N.
K.

ALLIED CHEMICAL CORP., MORRISTOWN, N.J.; AEROJET NUCLEAR CO., IDAHO
FALLS, IDAHO. AVAIL.NTIS

PREPARED IN COOPERATION WITH AEROJET NUCL. CO. PRESENTED AT
SPRING MEETING OF THE WESTERN STATES SECTION OF THE COMBUSTION INST.,
SEATTLE, 24-25 APR. 1972

♦ELECTRIC GENERATORS ♦WASTE UTILIZATION ♦WOOD ♦ECONOMIC ANALYSIS/
SYSTEMS ENGINEERING

BENEFICIATED SOLID WASTE CUBETTES AS SALVAGE
FUEL FOR STEAM GENERATION.
H.I. Hollander, P.E. and N.F. Cunningham. p.75-

TD National Incinerator Conference, New York, 1972.
803 Proceedings. New York, American Society of
.N34 Mechanical Engineers, 1972.
1972 353 p. illus. 28 cm.

"Papers presented at 1972 National Incinera-
tor Conference. New York, N. Y., June 4-7,
1972."

"Sponsored by ASME Incinerator Division."

The ominous "energy crises", the mounting burden
of solid waste disposal, and the appeal for environmental
enhancement and resource recovery has stimulated
imaginative multi-faceted approaches for solutions.

The concepts reviewed in this discussion hold promise
for:

- conversion of a relegated combustible fraction
of the solid waste stream into a "controlled quality sal-
vage fuel" with physical characteristics necessary to
permit amenable handling and storage to afford
practical consumption on an "as fuel needed" basis.
- lower thermal energy costs through use of this
beneficiated salvage fuel which would: a) permit con-
tinued and extended use of existing stoker-fired steam
(power) plants; and b) provide investment justification
for modernization of air pollution control systems.
- incentives to the private sector, (in particular
the secondary materials industry), for further commit-
ment to assist in coping with the ever growing solid
waste problem.

— the husbanding of our natural resources -- fossil
fuels, ferrous and non-ferrous raw materials, and
cellulose fibers and conservation of our land areas for
greater utilization.

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National Incinerator Conference, New York, 1972.
Proceedings. New York, American Society of
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"Papers presented at 1972 National Incinerator
Conference, New York, N. Y., June 4-7,
1972."

"Sponsored by ASME Incinerator Division."

Performance of the New Chicago Northwest Incinerator, p. 178 -

GEORG STABENOW

IBW-Martin Incinerator Group
East Stroudsburg, Pennsylvania

Operation of the incinerator plant was
started during September 1970 and in 1971 all four
400 tons/day units have been provisionally accepted by
the City.

The reverse reciprocating stokers with integrally designed welded waterwall boilers, economizers and electrostatic precipitators have undergone thorough tests for refuse burn-out, fly-ash collection, air pollution control and steam generator efficiency. Residue and fly-ash have been analyzed by competent consultants as well as by the U. S. Bureau of Mines. Two different organizations have tested the air pollution control performance of the electrostatic precipitators. One of the most interesting results of the boiler tests is the determination of the refuse heating value by the heat balance resulting from measurement of the heat loss and quantity of steam generated. The performance of the incinerator is described in this paper. Data carefully collected under supervision by independent testing organizations have been evaluated and are presented herewith. It is hoped that the information contained in this paper will help to establish the fact that an incinerator can be a good neighbor.

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Proceedings. New York, American Society of
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"Papers presented at 1972 National Incinerator
Conference, New York, N. Y., June 4-7,
1972."

"Sponsored by ASME Incinerator Division."

Recent Developments and Operating Experience with British Incinerator Plant P. 166 -

R. H. WATSON (Partner) and J. M. BURNETT (Associate)

Merz and McLellan

Newcastle upon Tyne, England

The paper mentions the change in Britain from separation/incineration plants with batch-type grates to continuous incineration of crude refuse on mechanical grates and tabulates the main features of all the recent plants in Britain, both operational and under construction or planned. Some details are given of operating experience and troubles.

It goes on to discuss the calorific value of refuse and outlines a series of tests to prove a method for direct measurement using the incinerator as a calorimeter. The paper goes on to consider heat use for power generation or district heating, or for the combined incineration of refuse and sewage sludge. It gives an outline of a pilot-scale process for recovery of nonferrous metals, and deals with recovery of other materials.

The paper covers British practice in dealing with environmental considerations, particularly dust emission and possible toxic gases constituents of the flue gases, with some notes on noise and concludes by mentioning likely trends in British practice, with special mention of the avoidance of vapor plumes which occur with attenuation of the flue gases by water sprays.

TD
803
.N34
1972

National Incinerator Conference, New York, 1972.
Proceedings. New York, American Society of
Mechanical Engineers, 1972.

353 p. illus. 28 cm.

"Papers presented at 1972 National Incinerator
Conference, New York, N. Y., June 4-7,
1972."

"Sponsored by ASME Incinerator Division."

Design of a Refuse Incineration Plant for the City of Coventry, England *p.166 -*

N. RAYMAN and PETER J. SCOTT

City Engineers Department
Coventry, England

Construction of the new refuse incineration plant in
Coventry is in progress and the paper describes the pro-
cesses which established the need for the plant and led to
the selection of the site, the acceptance by nearby
residents of that site as suitable for the purpose, and the
decision to proceed with construction. The factors
which determined the selection of a particular plant
capacity and led to the selection of a particular refuse
burning and boiler system are examined. The grate
and boiler system, gas cleaning, ash handling systems
and building features are described, together with the
contractual arrangements for construction.

TD
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.N34
1972

OPERATING EXPERIENCE IN THE SUSPENSION BURNING OF
WASTE MATERIALS IN CYCLONE INCINERATORS.

R.G. Mills and L.G. Desmon. *p.195 -*

National Incinerator Conference, New York, 1972.
Proceedings. New York, American Society of
Mechanical Engineers, 1972.

353 p. illus. 28 cm.

"Papers presented at 1972 National Incinera-
tor Conference, New York, N. Y., June 4-7,
1972."

"Sponsored by ASME Incinerator Division."

The technique of suspension burning has been utilized
for the incineration of general and industrial waste
materials. Four years of development work and success-
ful application on various sized units incinerating wood
products, paper, plastics, and other materials are
described. Typical performance values for a unit 3 ft in
diameter by 6 ft in length are a throughput rate of
3500 lb/h of material, an outlet gas temperature of
2800 F, and an exhaust heat content in excess of
28,000,000 Btu/h. This energy has been utilized for
steam generation and other process heat requirements.

USE OF REFUSE AS FUEL IN AN EXISTING
UTILITY BOILER.

F.E. Wisely, et al. p.97-

National Incinerator Conference, New York, 1972.
Proceedings. New York, American Society of
Mechanical Engineers, 1972.

353 p. illus. 28 cm.

"Papers presented at 1972 National Incinerator
Conference, New York, N. Y., June 4-7,
1972."

"Sponsored by ASME Incinerator Division."

The City of St. Louis, Missouri and the Union
Electric Co. are collaborating in a full scale test of the
feasibility of burning prepared refuse as supplementary
fuel in an existing pulverized coal-fired boiler. Raw
municipal refuse is milled to small particles, magnetic
metals removed and the remainder fired pneumatically
to a 125 mw boiler unit. The refuse comprises only a
small percentage of the total fuel requirement of the
boiler.

(At the time this paper was written, the project was
not yet in operation. It was anticipated that preliminary
operating data would be available for presentation by the
date of the Conference.)

ENERGY PLANTATION. Szego, G. C.; Fox, J. A.;
Eaton, D. R. pp 1131-1134 of 7th Intersociety Energy Conversion
Engineering Conference. Washington: American Chemical Society
(1972).

From 7th intersociety energy conversion engineering conference,
San Diego, California, USA (25 Sep 1972). See CONF-720928-

The solar energy falling on the Earth is far in excess of the
rates of usage of energy from all sources. The main problems
with solar energy are intermittency and low density. The use of
photosynthesis on a planned operational scale seems to solve these
problems in a cost-effective fashion, indeed highly competitive
with coal, and at the same time does not require inordinate land
areas. Technical and economic scenarios and analyses that com-
pare the cost of a million Btu delivered with that for fossil fuels
and nuclear energy sources are presented. (auth)

1972

PB-213 53472

Saint Louis City/Union Electric Co. Mo.
ENERGY RECOVERY FROM WASTE. A MU-
NICIPAL-UTILITY JOINT VENTURE.

1972, 20p EPA-SW-36d1

Grant OAG-EC-00312

Prepared in cooperation with Horner and Shifria,
Inc.

Paper copy available from GPO \$0.40 as
EPL17:36D1.

Descriptions: ("Waste disposal, "Heat recovery"),
("Combustion, Waste disposal), ("Electric power
generation, Waste disposal), Refuse disposal,
Boilers, Electric power plants, Fuels, Mixtures,
Materials handling. Cost estimates.
Identifiers: "Solid waste disposal.

The report discusses the recovery of thermal ener-
gy by burning shredded residential solid waste as
supplementary fuel in boiler furnaces. Briefly
discussed are the process details, the processing
facilities, the receiving and firing facilities, the test
boiler, and the economics and applicability.

Shehan, M. T.

Univ. of Virginia, School of Law,
Charlottesville, VA 22903

Steam production from incineration.

In Four reports: Markets for solid waste S. Cheikes, L.W.
Robinson; G. Shearer and M. Shehan. pp. 149-199. New York:
Council on the Environment of New York City, [Dec. 1972?].

No abs., illus., refs., from Text.

MUNICIPAL REFUSE : STEAM : GENERATORS : WASTE
REUSE : WASTE DISPOSAL : INCINERATION : NEW YORK
New York City.

New York City's history with steam generation from
incineration, the circumstances and conditions that make for
selection of this process in Europe, and Europe's success with this
process are discussed. Steam-generating incineration offers a
reasonable process for disposal of New York City's waste.

Technologically, a 1,000 TPD plant is feasible, and the amount of
steam delivered from such a plant is sufficient to substantially
reduce its operating cost. Prospects for a market for the steam are
good, provided the incinerator is located near its potential
customers. Air pollution standards may be met with the proper
control equipment. Other cities with a steam-generating incinerator
verify its reliability and efficiency in disposal and energy recovery.

Proceedings of the fifth mid-Atlantic industrial waste conference.
Fifth Mid-Atlantic Industrial Waste Conference. Proceedings. (Held Nov.
17-19, 1971). Sponsored by Drexel University, Philadelphia,
Pennsylvania and University of Delaware, Newark. Drexel University,
Philadelphia, Pennsylvania.

The problem of solid waste disposal can be solved in some cases
by on site incineration of combustibles at high temperatures. The heat
evolved from this operation could be used to generate steam or hot
water for on site use or distribution to other facilities. A case history of
such a program is provided. The use of a simple, automated system for
on site burning of wastes and the recovery of the heat from the
burning process is economically and environmentally worthwhile.

PB-209 271 PC\$9.00/MF\$0.95
Eavrogenics Co., El Monte, Calif.
SYSTEMS EVALUATION OF REFUSE AS A
LOW SULFUR FUEL VOLUME I

Final rept.,
R.M. Roberts, R. E. Sommerlad, A. P. Kononka,
S. T. Braunheim, and R. C. Hanson. Nov 71, 311p.
F-1295-Vol-1 APTD-1111
Contract CPA-22-69-22
See also Volume 2, PB-209 272. Prepared in
cooperation with Foster Wheeler Corp., Carteret,
N.J.

Descriptors: (*Refuse, *Fuels), (*Refuse disposal,
*Boilers), Design, Furnaces, Sulfur dioxide,
Abatement, Air pollution, Cost estimates,
Collecting methods, Combustion products,
Particles, Communitation, Separation, Capital
costs, Operating costs, Engineering drawings,
Incinerators.
Identifiers: *Solid waste disposal, Air pollution
abatement, Low sulfur fuels.

The fuel properties of refuse and the mechanics
and combustion technology associated with the
utilization of refuse as a fuel in generating utility
grade steam were systematically assessed. By
estimating the inventories and compositions of
refuse that would likely occur, the extent of S₀₂-
abatement that might be realized in using refuse as
a partial coal substitute was projected through the
year 2000. Ten different combined-fuel (coal +
refuse) fired boiler configurations were conceived
and then analyzed in terms of process variables
(plant power capacity, fuel-ratio, etc.);
performance/cost characteristics were also
predicted. Similarly treated were five plans for
modifying existing plants to refuse-burning
systems. At least one of the systems within the
first group was identified as being a more cost-
effective approach to refuse disposal than is
landfill. The cost model was developed to consider
all the major elements involved in the erection and
operation of the candidate refuse-burning systems.
Two new-plant configurations were extracted and
subjected to detailed engineering analysis. Cost
estimates were iteratively computed for the
resulting preliminary designs. (Author)

PB-209 272 PC\$9.00/MF\$0.95
Eavrogenics Co., El Monte, Calif.
SYSTEMS EVALUATION OF REFUSE AS A
LOW SULFUR FUEL VOLUME II

Final rept.,
R. M. Roberts, R. E. Sommerlad, A. P. Kononka,
S. T. Braunheim, and R. C. Hanson. Nov 71, 301p.
F-1295-Vol-2 APTD-1112
Contract CPA-22-69-22
See also Volume 1, PB-209 271. Prepared in
cooperation with Foster Wheeler Corp., Carteret,
N.J.

Descriptors: (*Refuse, *Fuels), (*Refuse disposal,
*Boilers), Combustion, Fouling, Furnaces,
Design, Reviews, Air pollution control equipment,
Air pollution, Abatement, Sulfur dioxide, Cost
estimates, Mathematical models, Bibliographies.
Identifiers: *Solid waste disposal, Air pollution
abatement, Low sulfur fuels.

As part of a study on the use of refuse as a low
sulfur fuel, the report presents topics concerning
this usage: Waste and fouling in refuse
combustion; State of the art survey on economic
and design characteristics of steam generators;
Cost model of using refuse as a fuel; Bibliography
of refuse combustion; and Glossary. (Author)

Energy Conservation and Waste Heat Utilization. A Bibliography with Abstracts.

Edward J. Lehmann.

National Technical Information Service, Springfield, Va. Jul 74. 147p NTIS-WIN-74-051
COM-74-11138/6WE PC\$20.00/MF\$20.00

The bibliography contains 142 selected abstracts of research reports retrieved using the NTIS on-line search system--NTISearch. The report is divided into two sections dealing with energy conservation. In the first, 50 reports are presented which concern all aspects of energy conservation including topics such as reducing electricity demand, conservation policies, and the reduction of heating and automotive fuel consumption. The second section covers all aspects of recovering waste heat from power plants, buildings, and industrial water. These 90 reports include studies of total energy systems, waste heat boilers, and the use of power plant waste heat for irrigation, heating, sewage treatment, and desalination.

CONSERVATION GOAL MET BY POLLUTION-FREE INCINERATION, HEAT RECOVERY. O'Connor, J. J. Power; 119: No. 4, 62-63(Apr 1974).

A case is described in which coal-fired boilers were replaced by incinerators. Heat reclaimed serves to generate steam that heats ovens, plate presses, paper-machine dryer rolls, the plant, assorted processing equipment, and feeds turbine-driven paper machines. Liquid wastes are atomized and burned as fuel oil being sprayed into the combustion chamber as a fine mist. Solid wastes are burned in a double-vortex burner system. The conversion allows for yields of 160,000 lb of steam per hour and a clean stack. (MCW)

DISTRICT HEATING CAN CUT WASTAGE FROM NUCLEAR PLANTS. Jenkins, N. Energy Int.; 11: No. 3, 25-28 (Mar 1974).

A review is given of progress made in several countries on the performances of nuclear power plants for combined production of electricity and hot water for district heating. Fear still exists about the safety of atomic power, and power plants will continue to reject twice as much heat energy as they use to generate electricity. The public must be persuaded that there is little risk and that precautions are taken to prevent disaster. (MCW)

ENGINEERING GUIDELINES FOR TOTAL ENERGY ARE EVEN MORE VITAL DURING FUEL SHORTAGE. Kauffmann, W. M. Power; 119: No. 4, 73-75(Apr 1974).

Large total-energy facilities, from 3 to 20 MW in capacity, are studied, but the guidelines are applicable to small units also. Heat-balance analysis, fuel costs, load factor, load-profile match, and control-system design are engineering parameters for total-energy systems that will improve fuel economy. (MCW)

(ORNL-HUD-MIUS-7) MIUS TECHNOLOGY EVALUATION: LITHIUM BROMIDE-WATER ABSORPTION REFRIGERATION. Payne, R. R. (Oak Ridge National Lab., Tenn. (USA)). Feb 1974. Contract W-7405-eng-26. 32p. Dep. NTIS \$4.00.

Air conditioning by absorption refrigeration that utilizes heat recovered from engines and from incineration of solid waste is a utility service that can be included in a MIUS. This report reviews the suitability of lithium bromide-water absorption refrigeration for such an application. Types and sizes of units manufactured and their availability are discussed. Single-effect lithium bromide-water absorption systems are available from domestic manufacturers, and double-effect systems will probably be available in the near future. Capital and operation and maintenance costs are given for single-effect absorption-refrigeration systems. Where waste heat is available from electric power generation, a total energy system will use less fuel than a conventional system supplying electric power and using compressive refrigeration over a wide range of conditions. Fuel consumption comparisons are made between total energy and conventional systems providing the same service. (auth)

MIUS Technology Evaluation. Prime Movers.

G. Samuels, and J. T. Meador.
Oak Ridge National Lab., Tenn. Apr 74, 73p
ORNL-HUD-MIUS-11 PC\$5.45/MF\$1.45

Prime movers suitable for supplying electricity and using exhaust heat to heat and cool small communities served by a MIUS are evaluated from the standpoint of performance and economics. Present economic and technology considerations limit the choice of prime movers in the 150- to 1000-kW range to gas and steam turbines, spark-ignition gas engines, and compression-ignition diesel and dual-fuel engines. The fuel economy, maintenance cost, and equipment costs for gas turbine-generator units and for the various internal-combustion piston engine-generator units are included. (Modified author abstract)

(SLA-74-91) SOLAR COMMUNITY ENERGY FOR RESIDENTIAL HEATING, COOLING, AND ELECTRIC POWER. McCulloch, W. H.; Lee, D. O.; Schimmel, W. P. Jr. Sandia Labs., Albuquerque, N. Mex. (USA). Feb 1974. Contract AT(29-1)-789. 18p. (CONF-740213-9). Dep. NTIS \$3.00.
From 140th meeting of The American Association for the Advancement of Science, San Francisco, California, USA (25 Feb 1974).

A series of systems studies on the potential uses of solar energy was conducted at Sandia Laboratories. The outcome of these studies is a new concept, the Solar Total Energy Community. This is a residential community which could significantly reduce its fossil fuel energy consumption by using the sun as the source for most of the community's energy needs. A system computer program, developed for the study, was used to examine several candidate systems and to optimize the operation of the interrelated components which provide space heating, air conditioning, water heating, and electricity for residences and light commercial buildings. An experimental program has been initiated to investigate various technological areas relative to the concept. The study shows that the Solar Community is technologically feasible and that the projected costs warrant the further investigation of solar energy as an alternative residential energy source. This paper reviews the previous work, reports recent findings and improvements, and presents the current status of the continuing analytical and experimental efforts. (auth)

(SLA-74-124) SOLAR TOTAL-ENERGY COMMUNITY PROJECT. Brandvold, G. E. (Sandia Labs., Albuquerque, N. Mex. (USA)). Mar 1974. Contract AT(29-1)-789. 9p. Dep. NTIS \$4.00.

The concept of a solar total-energy community entails collecting solar energy at a central area, converting part of it to electricity, and distributing the rest of it to homes and/or businesses for space heating or cooling. The Sandia Laboratories' concept for such uses of solar energy, its departure from other solar-energy approaches, and the development program being conducted to further explore its feasibility are described. (auth)

POWER PLANT PROVIDES 86% EFFICIENCY.

J.P. Zaryk.

Oil & Gas Jour, v.72, no.21, May 27, 1974, p.48-51.

A COMBINED-cycle power plant at Dow Chemical of Canada has been operating since mid-1972 with efficiency of more than 86%. Heat rate is less than 4,000 BTU/kw. Integrated into an existing power plant, it provides the total energy needs for the company's chemical complex at Sarnia, Ont.

The new power plant consists of two 51,800-kw-gas-turbine generators (G.E. MS7001) with two multipressure waste-heat recovery boilers (Foster Wheeler).

TITLE: The Inverted Brayton Cycle for Waste-Heat Utilization
AUTHOR: Wilson, D.G.; Dunnean, N.E.
CORPORATE AUTHOR: Massachusetts Institute of Technology
ADDRESS: Room 3-447, Cambridge, MA 02139
PUBLICATION DESCRIPTION: Paper 73-67-90, contributed by the Gas Turbine Division of The American Society of Mechanical Engineers for presentation at the Gas Turbine Conference and Products Show, Washington, D.C., April 8-12, 1973.

ABSTRACT: When a waste-heat boiler is added to a gas turbine, the additional pressure loss reduces the power delivered. However, when a compressor is added downstream of the boiler, the lost power can not only be restored but, in many cases, the net power level can be substantially increased above the base-turbine case. This approach employs the "inverted" Brayton cycle, which is analyzed in this paper for thermodynamic and economic performance. (auth)
AVAILABILITY: ASME, 345 East 87th Street, New York, NY 10017, (\$3.00; \$1.00 to ASME members)

Mechanical and Acoustical Signature Analysis of Engine-Generator Units to be Used at the Department of Housing and Urban Development Total Energy Plant, Jersey City, New Jersey.

Richard F. Burchill.
Mechanical Technology, Inc., Latham, N.Y. May 73, 375p
NBS-GCR-74-22
COM-74-10934/9WE PCS16.75/MF\$1.45

The report summarizes the acoustical vibration and stack gas temperature and conditions of each of five diesel-electric sets tested in the vendor's factory. The data in this report was collected simultaneously with fuel, cooling water and electrical transient data during the factory acceptance tests. The tests were supervised by NBS staff and were required by the purchase specifications. The purchase specifications were based upon a total energy performance specification developed by NBS for this project. (A Performance Specification For A Total Energy Plant At The Jersey City Breakthrough I Site, NBS Report No. 10313, December 28, 1970). Signature analyses of each engine over the test load range were calculated and plotted. The signature analyses show machinery unbalance, rotating component looseness, ball and roller bearing deterioration and gear damage or wear. These signature analyses are baseline data which will be compared with signature analyses taken at future dates as the engines age. Changes in the signature analysis will be used to predict required maintenance services.

TK
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Intersociety Energy Conversion Engineering Conference, 8th Philadelphia, Pa., 1973.
Proceedings. New York, American Institute of Aeronautics and Astronautics [1973]
847 p. illus. 29 cm.
Held at: University of Pennsylvania, Philadelphia, Pa., August 13-16, 1973.
Sponsored by: American Institute of Aeronautics and Astronautics [and others]

A Selective Total Energy System for a Residential Complex - W. E. MAYO, J. C. PURCUPILE.....	389
Stirling Engine Design Studies of an Underwater Power System and a Total Energy System - H. A. JASPERS, F. K. du PRE.....	588
Integrated Utilities for Remote Alaskan Villages - D. R. WRIGHT.....	643
The Modular Integrated Utility System - A New Approach to the Supply of Utility Services - G. S. LEIGHTON.....	648
Technology Evaluation for MIUS - A. J. MILLER, G. SAMUELS, W. J. BOEGLY, L. BREITSTEIN.....	653

1973

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Economic Evaluation of Total Energy: Guidelines.

D. Glenn, J. Oplinger, and J. Orlando.
Decision Sciences Corp., Jenkintown, Pa. Jul 73. 59p
HUD-DSC-1
PB-228 683/9WE PCS3.75/MF\$1.45

These guidelines provide a screening tool which can be used by the private and public sectors to determine the economic applicability of total energy systems for residential developments. The guidelines are designed to allow a simple, straightforward, low-cost determination of whether or not a complete engineering feasibility study is justified. They do not eliminate the need for a complete feasibility study, requiring the services of engineering consultants experienced with total energy systems.

Economic Evaluation of Total Energy.

D. Glenn, J. Oplinger, and J. Orlando.
Decision Sciences Corp., Jenkintown, Pa. 12 Jul 73. 490p
HUD-DSC-2
PB-228 893/4WE PCS9.75/MF\$1.45

Total energy systems are onsite power generation systems with heat recovery. By generating electricity on the premises, it is possible to recover normally wasted heat and use it to provide space heating, cooling, and domestic water heating. The objective of the study was to develop economic evaluation guidelines which could be used by the private and public sectors as a screening tool to determine the applicability of total energy systems for residential developments.

1973

1973

GEOTHERMAL DISTRICT HEATING. *Estuaries*, 3, 2, (Vermir H/F, Reykjavik), pp 123-134 of Geothermal Energy. Armistead, H. C. H. (ed.). Paris: United Nations Educational, Scientific and Cultural Organization (1973).

A history of the application of geothermal energy for heating of houses is discussed for Iceland, Hungary, Japan, New Zealand, and USSR. The economics and technical aspects of the systems are described. The development of the geothermal areas feeding the system in Reykjavik is described, and then principal data regarding the geothermal district heating system are given. The Reykjavik system saves about 180,000 tons of oil annually that would have had to be imported, and the annual cost of heating for the customers is only 60% of the cost of heating with oil. (20 references) (MCW)

EFFICIENCY OF NUCLEAR POWER STATIONS FOR DISTRICT HEATING. Arsen'ev, Yu. D.; Voronkov, M. E.; Sinev, N. M. *At. Energ. (USSR)*; 35: No. 3, 197-198 (Sep 1973). (In Russian).

The efficiency of a system for the supply of thermal and electrical power to the city of Moscow was mathematically analyzed on the basis of two variants. In the first, the thermal and electrical power was supplied by a nuclear electrical power plant and an organically fueled condensation electric plant. In the second, the power was supplied by a nuclear electrical power plant, a condensation electrical power plant, and a district heating nuclear power plant. The analysis showed that replacement of thermal and electric power plants with condensation power plants and district heating nuclear power plants does not result in over-expenditure of organic fuel. (JSR)

DISTRICT HEATING CAN ANSWER REFUSE DISPOSAL PROBLEM. *Energy Int.*; 10: No. 10, 12-14 (Oct 1973).

Incineration for the disposal of domestic and industrial wastes is coupled to district heating networks for the utilization of the energy generated. Problems for urban areas are the maintenance of a clean and tidy, healthy and enjoyable environment. The incineration of wastes combined with district heating facilities is discussed for several cities. Systems are advanced in Europe, and the systems in Nottingham and Coventry are discussed. The Japanese experience with waste disposal heat is explained. Stockholm's Hogdalen incinerator plant is one of two serving the city. The operation at the systems in Mannheim, Germany, France, and in North America is described. (MCW)

DISTRICT HEATING TURBINE FOR NUCLEAR HEAT AND POWER STATIONS. Bunin, V. S.; Vasil'ev, M. K. *Therm. Eng. (USSR) (Engl. Transl.)*; 20: No. 2, 22-26 (Feb 1973).

Translated from *Teploenergetika*; 20: No. 2, 18-21 (1973). An investigation was made to select the design of a new turbine to operate at main steam conditions of 60 kgf/cm² and 275 C. Comparisons have shown that the water-moderated water-cooled reactors are desirable to operate with the district heating turbines for performance and efficiency. The annual characteristics of the T-150/250-60 turbine plant with connected heat load of 1500 Gcal/h at different heating factors of 1.0, 0.7, 0.5, and 0.4 were calculated. The characteristics of a nuclear heat and power station with one turbine are also determined. (MCW)

TOTAL ENERGY FOR TEXAS A AND M. Boyce, M. P.; Redman, J. C.; Bale, Y. S. *Gas Turbine Int.*; 14: No. 5, 34-41 (1973).

The total energy power plant system at Texas A&M University is described. The natural gas or the fuel oil is used as the original energy source to drive the gas turbine or to boilers which produce the steam necessary to drive the steam turbines. Low pressure steam is extracted from the turbines and used to produce heating water, chilled water, and domestic hot water. The utilities are then distributed throughout the campus to the various buildings. The unused utilities are then returned to the power plant where they are again recycled through the plant and redistributed. (auth)

Title: Total Energy: A Key to Conservation
Authors: Beall, S. E., Jr.
Corporate Author: Oak Ridge National Laboratory
Address: P.O. Box 1, Oak Ridge, TN 37830
PUBLICATION DESCRIPTION: Consulting Engineer, 40(3), 180-185

PUBLICATION DATE: 1973, March
ABSTRACT: Studies of the beneficial uses of waste heat from large steam-electric generating systems and smaller "total energy" systems are described. Extracted and back-pressure heat from steam turbines can be used to desalt water, in agro-industrial complexes, to provide low-temperature heat for urban areas, and in agriculture and aquaculture. Each of these applications is described. It is estimated that 10% of the total fuel used in power stations could be saved if half of the new installations supplied heat as well as electricity. (NRC)

MODULAR INTEGRATED UTILITY SYSTEMS (MIUS) SHOW PROMISE.
Energy Today, v.1, no.1, Sept.17,1973, p.1,2.

Recent studies by Federal Agencies indicate that the widespread use of Modular Integrated Utility Systems in place of central station power facilities could reduce total U.S. residential energy consumption by as much as 8.5% in 1986.

(CONF-730811-4) TECHNOLOGY EVALUATION FOR

MIUS. Miller, A. J.; Samuels, G.; Boegly, W. J.; Brettlein, L. (Oak Ridge National Lab., Tenn.). 1973. 7p. Dep. NTIS \$3.00.

Modular integrated utility systems (MIUS) would provide developing communities with energy, water, and sanitary services from a single utility employing a total system concept to balance the requirements for environmental quality, conservation of resources, and low total costs. The MIUS may be sized to accommodate perhaps 100 to 3000 multifamily dwelling units, nearby single-family housing, and associated commercial facilities. The technology necessary to build a MIUS currently exists. An on-site utility with power generation based on prime movers, such as diesel engines or gas turbines and on use of recovered thermal energy for heating and air conditioning, could be significantly more efficient in energy utilization from fuel than new conventional systems in most parts of the U.S. The costs of the on-site energy utility service would be in the same range as service from most new conventional systems. Incineration of solid waste with heat recovery would result in significant conservation of fuel. Liquid waste could be adequately treated on-site. Emissions of air pollutants and ambient air quality resulting from MIUS would conform to present and currently projected standards. (MCW)

TURBINE TOTAL ENERGY FOR OFFSHORE RIGS.

Witmer, B. R.; Culp, R. E. (North American Turbine Corp., Houston, TX). Gas Turbine Int.; 14: No. 6, 14-18(1973).

The advantages of packaged gas turbine powered total energy systems for remote operations are outlined. These include space savings, favorable weight/power ratios, vibrationless operation, recoverable exhaust energy, and cleaner exhaust. Major system components and economics are discussed for systems of the 3 to 6 MW capacity. (MCW)

(ORNL-HUD-MIUS-9) MIUS TECHNOLOGY EVALUATION: SOLID WASTE COLLECTION AND DISPOSAL, AUGUST 1973. Boegly, W. J.; Haynes, V. O.; Hise, E. C.; Compere, A. L.; Griffith, W. L. (Oak Ridge National Lab., Tenn.). Sep 1973. Contract W-7405-eng-26. 87p. Dep. NTIS \$5.45.

Solid waste collection and disposal may be performed within the Modular Integrated Utility Systems (MIUS), which will serve from 100 to 3000 dwelling units. Current and future technology are evaluated for MIUS use. Depending on the size and the types of buildings in the MIUS, it may be practical to make use of innovations in solid waste collection using commercially available equipment. Individual home compaction units, apartment house compactors or bailers, and vacuum, slurry, or pneumatic collection systems might be applied to reduce the cost of collection and improve the environmental impact of solid waste collection practices. However, the costs of vacuum collection systems currently appear to be reasonable only in very highly populated areas, such as those occupied by medium- and high-rise buildings. Changes in the form of the collected material may affect the disposal operation. For example, if wastes were balled at each apartment building, it might not be necessary to provide expensive compaction equipment at a sanitary landfill site. Conversely, if wastes were to be burned for heat recovery, a vacuum collection system might be more desirable to provide the fuel for the incineration in a more constant fashion and eliminate storage facilities at the incinerator. Many methods for solid waste disposal look promising, but the economics and operating problems are not well understood in the size ranges for use in a MIUS. Sanitary landfill could be used, but heat recovery from incineration would be more in keeping with MIUS objectives. Data indicate that the economics of employing incineration with heat recovery might be acceptable. However, very little equipment development work has been done in systems in the range of small sizes suitable for the MIUS, and there is little field-operating experience. Additional equipment cost data and analyses of specific housing complexes are required to obtain definitive economic evaluations. Because of the size of the MIUS, resource recovery from the incinerator residue from an individual MIUS does not appear promising because of the equipment required and the relatively small amount of recoverable material available. If there were enough MIUSs in one area, it might be possible to construct a central recovery plant at a later date when sufficient material is available. It is concluded that sufficient innovative technology is available at this time to consider its application to solid waste collection and disposal in near-term MIUS designs. (10 figures, 21 tables, 90 references) (auth)

1973

ENERGY CONCEPTS FOR NEW ERA. Heat Eng.;

1973

ENERGY CONCEPTS FOR NEW ERA. Heat Eng.;

1973

ENERGY CONCEPTS FOR NEW ERA. Heat Eng.;

DISTRICT HEATING COULD CUT HEAT LOSS FROM
CONDENSING STATIONS. Haag, A. (Molmoe District Heating
Utility, Sweden). Energy Int.; 10: No. 11, 24-25(Nov 1973).
A proposed single-pipe district heating system using heat pumps
to extract low grade energy from condenser circulating water is
described. The release of enormous quantities of heat from all
condensing power stations has been ignored. For example, only
32% of the energy available in the fuel for a light-water reactor,
is converted to electricity, the only useful product of a nuclear
power station. A station with an electrical output of 5,000 MW
releases about 10,000 MW of heat that is presently unusable.
The distances between a nuclear power station and the nearest
large community are large, and the use of this heat solely for
space heating is at present impossible. With the use of the sys-
tem described, no significant reduction in electricity production
occurs when a condensing set is converted to back-pressure
operation. (MCW)

A LOOK AT TOTAL ENERGY SYSTEMS.
Tech. News Bulletin, NBS, May 1973, p.122,123.

Properly designed total energy systems could
achieve energy savings of 28 to 40 percent if
applied to medium-sized housing developments in
six selected areas of the United States, according
to an NBS study.

DISTRICT HEATING FOR SWITZERLAND: THE TOTAL
ENERGY CONCEPT AND ITS POSSIBLE ROLE IN A LOW-POLLU-
TION OVERALL ENERGY SUPPLY. Mohl, R. Brown Boveri
Rev.; 60: No. 6, 263-264(Jun 1973).

Roughly 45% of Switzerland's total energy consumption is ac-
counted for by air-polluting individual oil-fired systems for space
heating and hot water services. With reference to the proven
technique of the combined heat and power plant, a model is pro-
posed that, in addition to its established advantages, has two deci-
sive features: 1.) The heat for the district heating networks can be
generated from any energy source, in future especially from the
source that is the most suitable in terms of atmospheric pollution
and a general supply policy; and 2.) By coupling heat and power it
is possible to provide the urban centers with hot water, and heat
the great majority of Switzerland's other population centers direct
with electricity generated at the same time. This would eliminate
over 90% of the separately fired systems. Domestic hot water will
be heated on a base-load arrangement by nuclear power stations,
partly by supplies of heat, partly by electricity. (auth)

PRESENT-DAY CONDITIONS AND PROSPECTS FOR THE
DEVELOPMENT OF DISTRICT HEATING.

Thermal Engineering, April 1972, Vol.19, No.4
pp 1-6.

TK 2896.155 1972

URBAN UTILIZATION OF EXTRACTED HEAT AND
WASTE HEAT FROM CENTRAL STATION POWER PLANTS.

Beall, S. E. Jr.; Miller, A. J. (Oak Ridge National Lab., TN).
pp 1223-1229 of 7th Intersociety Energy Conversion Engineering
Conference, Washington, American Chemical Society (1972).

From 7th intersociety energy conversion engineering conference,
San Diego, California, USA (25 Sep 1972). See CONF-720925-.

An analysis is presented of the feasibility of providing thermal
energy as well as electricity to urban areas from central station
steam-electric power plants. Consideration is given to the use of
thermal energy for applications such as industrial processes,
building space heating, air conditioning, sewage treatment, agri-
culture, and aquaculture. The use of dual-purpose plants sig-
nificantly reduces the consumption of fuel and lessens the environ-
mental impact of providing energy as compared to conventional
systems. Areas of multifamily dwellings and other multistoried
buildings could be served in new cities, or renewed old cities, at
costs comparable to those incurred with more conventional sepa-
rate systems. However, it would require more planning of facili-
ties and coordination of diverse organizations than we normally
employ. The costs and dislocations associated with retrofitting
existing cities would cause each city to be a separate case. (auth)

1972

1971

1972

TK2896.I55 1972

CRITICAL LOOK AT TOTAL ENERGY SYSTEMS AND EQUIPMENT. Gamze, M. G. (Gamze-Korobkin-Chiager, Inc., Chicago). pp 1263-1268 of 7th Intersociety Energy Conversion Engineering Conference. Washington; American Chemical Society (1972).

From 7th Intersociety energy conversion engineering conference; San Diego, California, USA (25 Sep 1972). See CONF-720923-. The total energy concept, the history of the concept, and the problems involved in designing and installing TE systems are discussed. The basic problem is that such systems have to be custom designed around components that are not always totally suited for TE application. This necessitates extensive engineering to design a dependable installation and rigorous maintenance procedures to insure system reliability after the job has been placed in operation. A detailed listing of the problems of the TE concept is presented. This is followed by specific recommendations to improve upon existing hardware and to develop new hardware in order to make the TE concept a viable one that will permit its potential for conserving fossil fuels and reducing air, water, and thermal pollution to be realized. (auth)

(AD-743494) ENGINEERING-ECONOMIC POTENTIAL FOR POWER-PLANT WASTE HEAT UTILIZATION. Fuecher, R. J.; Goodson, R. E. (Purdue Univ., Lafayette, Ind. (USA). Automatic Control Center). May 1972. Contract N00014-67-A-0226-0012. 37p. (ACC-72-6). NTIS.

The work was undertaken to formulate a quantitative mechanism that would facilitate evaluation of power plant waste heat utilization potential. Heat at usable temperatures is made available by extraction from the turbine. Incremental rates for reductions in electric output and heat rejection are obtained for various amounts and locations of waste heat extraction. The maximum justifiable investment (MJJI), for a waste heat system, is calculated using a present worth criterion and at constant thermal input to the turbine cycle. A series of thermal market prices is applied in order to determine the sensitivity of the MJJI to potential market values. Results for a typical medium-sized plant are summarized. (GRA)

N73-22912# Grumman Aerospace Corp., Bethpage, N.Y. Research Dept.
CLEAN AND ATTRACTIVE URBAN POWER SYSTEMS
James T. Yen Aug. 1972 36 p refs Presented at the Intersociety Energy Conservation Eng. Conf., San Diego, Calif., 25-29 Sep. 1972
(RE-439J) Avail: NTIS HC \$4.00

The siting and waste problems facing the power industry at the present time are examined. It is proposed that these problems be resolved by integrating clean power plants into community centers. This can be done in such a way that not only power but also year-round recreation and job-training will be enjoyed and utilized by the residents. More specifically, the result is a new type of integrated system that is comprised of total energy gas turbine power plants to be located in underground sites within the community centers, and year-round recreation, job-training, and other facilities to be designed to suit local needs and to be located within the same community centers. Author

TITLE: Comparing Combined Cycle Plants
AUTHOR: Tomlinson, L.O.
CORPORATE AUTHOR: Power Systems Engineering, Inc.
PUBLICATION DESCRIPTION: Gas Turbine International, 13(6), 20-28
PUBLICATION DATE: 1972, November-December
ABSTRACT: Combined cycle power plants for electric utility application are described and compared. The three basic types are the unified heat recovery cycle, the supplemental fired heat recovery cycle, and the exhaust fired cycle. All three systems use gas turbines and condensing steam turbine generators. Each system is described in some detail, with schematic diagrams, and graphs of temperature-entropy diagrams, and graphs of heat rate and rejection, operating characteristics, range of installation costs, and heat rate - power curves. Combined cycle systems are well suited for use in decentralized utility systems providing industrial customers with electric power and steam or hot gas for process heat. Fuel utilization for a decentralized power and steam plant is compared with that for a conventional central station plant. Future trends that are briefly mentioned are efficiency improvement, increased unit size, coal gasification combined cycles, and large mounted plants. (SPN)

TITLE: Total Energy Conference, Session I, Exposition of Subject; An Introduction to Total Energy Systems.

AUTHOR: Harasorth, J.P.; Garside, J.E. (Chairman)
CORPORATE AUTHOR: Shell International Gas Limited
ADDRESS: London, England
PUBLICATION DESCRIPTION: Session I, Paper 1, presented at Total Energy Conference held at Brighton, England 29 November to 1 December 1971, p. 7-21 in proceedings
PUBLICATION DATE: 1971

SPONSOR: Institute of Fuel
ABSTRACT: The main considerations affecting total energy systems are briefly covered to act as an introduction to the subject. The interest in TE systems lies in their potential for reducing costs of power and heat to industrial and commercial users. The three main types of system, using back-pressure steam turbines, gas turbines and reciprocating internal combustion engines, are briefly described, and a simple method of visualizing the source of the potential energy bill savings from each system is indicated. The need to make detailed analyses of the various methods of supplying the heat and power requirements of each plant is emphasized. Comment is also made on the subjects of reliability, availability, type of power required, design and maintenance of TE systems, their financing, and their contribution to reducing atmospheric pollution and improving the national economy. (auth)
AVAILABILITY: Institute of Fuel, 18 Devonshire St., Portland Place, London W1N 2AS, England (£83.65 for entire proceedings)

Proceedings of the fifth mid-Atlantic industrial waste conference.
Fifth Mid-Atlantic Industrial Waste Conference. Proceedings. (Held Nov.
17-19, 1971). Sponsored by Drexel University, Philadelphia,
Pennsylvania and University of Delaware, Newark. Drexel University,
Philadelphia, Pennsylvania.

The problem of solid waste disposal can be solved in some cases
by on site incineration of combustibles at high temperatures. The heat
evolved from this operation could be used to generate steam or hot
water for on site use or distribution to other facilities. A case history of
such a program is provided. The use of a simple, automated system for
on site burning of wastes and the recovery of the heat from the
burning process is economically and environmentally worthwhile.

TITLE: Total Energy Conference, Brighton 1971

AUTHOR: Simmonds, P.A. (Chairman)

CORPORATE AUTHOR: Institute of Fuel

ADDRESS: 18 Devonshire St., Portland Place,
London W1N 2AU, England

PUBLICATION DESCRIPTION: Conference held at

Brighton, England 29 November to 1 December

1971, Proceedings Volume 1: Papers, 372 p.

PUBLICATION DATE: 1971

ABSTRACT: This Conference consists of seven

sessions with the following titles:

Exposition of Subject: Evaluation and

Feasibility Studies: Total Energy: Financing

and Operation: Price Movers: Heat Recovery

Systems: Examples and Short Papers Looking

Ahead. (HFG)

AVAILABILITY: Institute of Fuel (343.65)

TITLE: Use of Steam-Electric Power Plants to

Provide Thermal Energy to Urban Areas

AUTHOR: Miller, A.J.; Payne, R.R.; Lackey, R.S.;

Sannala, G.; Reath, H.T.; Regen, E.W.;

Savolainen, A.N.

CORPORATE AUTHOR: Oak Ridge National Laboratory,

Civil Defense Research Project

PUBLICATION DESCRIPTION: ORNL-RUD-18, 195 p.

PUBLICATION DATE: 1971, January

SPONSOR: U.S. Dept. of Housing and Urban

Development

ABSTRACT: This study has shown that with

coordinated planning of energy centers and

new cities, it would be feasible to provide

thermal energy from steam-electric power

plants to urban areas. With nuclear plants

the siting with respect to nearby populations

could be in accordance with present-day

practices. It is concluded that there should

be a national effort to determine

specifically where new power plants could be

sited to provide low-cost thermal energy, as

well as electricity to new cities and

existing urban areas. (Auth)

(PB-207300) NUCLEAR ENERGY FOR A NEW TOWN.
Hammerschlag, D.; Rose, V. C. (Rhode Island Univ., Kingston
(USA)). Aug 1971. 76p. Dep. NTIS \$6.00. -

This document is concerned with methods of utilizing the waste
heat from a proposed nuclear generating facility in an industrial -
municipal complex. Several products and processes are proposed,
including marine pharmaceuticals, chemical production, municipal
waste processes, food production and processing, and residential -
recreational uses. Sewage treatment was selected as the most
promising use of the heat. This nonseasonal process can provide
a solution to two regional problems: augmentation of municipal
water supplies and elimination of a major source of water pol-
lution. In the proposed system, sewage from the metropolitan
Providence, R. I., area would be piped to the vicinity of the power
plant, receive primary, secondary, and tertiary treatment to con-
vert it to potable water and be piped back to the city's reservoir
system. Heat from the power plant would be used in each stage to
accelerate the process. Cost of the entire system was estimated
at 74.3 million dollars. (auth)

1971

PB-207 791

Environetics Co., El Monte, Calif.

COMBINED FIRING SYSTEMS FOR SPECIFIC

METROPOLITAN AREAS.

Final rept.

R. M. Roberts, and R. C. Hanson. Nov 71, 168p.

F-0303 APTD-0951

Contract EPA-EHSD-71-9

Descriptors: (*Waste heat boilers, *Incinerators),

(*Refuse disposal, Urban areas), (*Heat recovery,

Incinerators), (*Refuse, *Fuels), Air pollution,

Garbage disposal, Sulfur, Design criteria, Cost

estimates, Operating costs, Capital costs, Pennsyl-

vania, Ohio, Steam electric power generation,

Combustion products.

Identifiers: *Low sulfur fuels, *Solid waste

disposal, *Air pollution control, Philadelphia

(Pennsylvania), Cleveland (Ohio).

The purpose of the present study was to develop

for two major cities, design recommendations and

procedures for the disposal of refuse, a low sulfur

fuel, with heat recovery in utility grade boilers. As

earlier study in this area resulted in the identifica-

tion of optimal system design configurations and

quantification of benefits to the environment and

the economy. The program has applied that

knowledge to specific case study areas. Arrange-

ments with two cities having high SO₂ burdens and

growing solid waste burdens were made; these

were Philadelphia, Pennsylvania, and Cleveland,

Ohio. Information required for the study was col-

lected and analyzed. Specific design packages

were then developed for each city. The report

presents projections describing the future nature

of the city refuse-fuel inventories, specific recom-

mendations as to plant types, sizes, and sites, cost

analyses of operations involving the utilization of

such systems, and estimated reduction in SO₂ and

particulate emissions. From these data, the con-

clusion can readily be drawn that the systems

recommended would be more cost-effective than

the methods that are now in use. (Author)

BASIC ECONOMICS OF INDUSTRIAL TOTAL ENERGY SYSTEMS. The phrases 'Total Energy' and 'On-Site' power systems are relatively new promotional names for the old concept of generating electricity or shaft horse power at or near the point of utilisation. 'On-Site' generation implies that the heat released by the prime mover is not used, whereas 'Total Energy' systems use some or all of the available heat. In both cases the main purpose of the system is to produce electrical or shaft power. The primary incentive to use Total Energy Systems lies in the potential savings to the user. There are many possible ways to supply the heat and power needs of a factory and the selection of the optimum method is a complex problem. A method of visualizing the relative importance of some of the major factors in the selection is proposed, and an illustrative example is included. Reference is also made to the services provided by 'Third Party' companies, and the likely effect of Total Energy systems on energy policies. It is concluded that the current compromise of centrally generated power and locally generated heat can be both wasteful of fuel and capital resources in comparison with a good Total Energy system.

Harnsworth, John Peter Shell Int Gas Ltd, London, Engl. *World Energy Conf.* 8th, Trans, Bucharest, Rom, Jun 28-Jul 2 1971 v 6, pap 3.3-126, 17 p. Available from Rom Natl Comm of the World Energy Conf, Bucharest, 1972.

TK
1041
.D5

PB-206 816

Dynatech Corp., Cambridge, Mass.
A SURVEY OF ALTERNATE METHODS FOR COOLING CONDENSER DISCHARGE WATER. TOTAL COMMUNITY CONSIDERATIONS IN THE UTILIZATION OF REJECTED HEAT.
Water pollution control research series.

Nov 70, 62p W72-04830, EPA-16130-DHS-11/70

Contract EPA-12-14-477

Revision of report dated Jun 70.
Paper copy available from GPO \$0.65 as
EP2-10:16130DHS11/70.

Descriptors: (*Heat recovery, *Electric power generation), (*Water pollution, Heat), Utilization, Heating equipment, Thermodynamics, Feasibility, Irrigation, Desalting, Sewage treatment, Aquaculture, Abatement.
Identifiers: *Thermal pollution.

The quantities of electric energy consumption and associated heat rejection quantities, their present and projected allocation throughout the different sections of the country, and their relation to other forms of energy consumption are reviewed and tabulated. Thermodynamic constraints on a solution to the thermal pollution problem are defined. Feasibility of possible application of waste heat usage are reviewed in the field of heating and air-conditioning, aquaculture, process industry, irrigation, sewage treatment, desalination, snow or ice melting and integration with municipal water systems. (Rainwater-EPA)

PB-207 870

Pacific Northwest Water Lab., Corvallis, Oreg.
THERMOELECTRIC GENERATORS POWERED BY THERMAL WASTE FROM ELECTRIC POWER PLANTS.
Moshafa A. Shirazi, Oct 70, 30p W72-06306, EPA-WQO-16130-10/70

Paper copy available from GPO \$0.45 as
EP2-10:1613-10/70.

Descriptors: (*Electric power generation, *Heat recovery), (*Thermoelectric power generation, Heat recovery), Thermal power plants, Feasibility, Flue gases, Heat exchangers, Cost estimates, Condensers (Liquefiers), Heat transfer.
Identifiers: Thermal pollution.

The feasibility of recovering electricity from the waste heat of electric power plants was assessed. Sources considered were: stack (flue gas, gas-turbine exhaust, and condensing steam. Typical 1600 MW fossil-fuel steam plants and gas-turbine plants were used as examples. Flat plate heat exchangers were designed with thermoelectric couples arranged in series within the plates. Heat flux, conversion efficiencies, and flow friction losses were calculated. Except for the condenser application, the friction losses are several times the thermoelectric power generated. Under favorable conditions, 3 to 9 MW is obtainable from the thermoelectric condensers. The high material cost, however, precludes all such applications today. (Author)

Diamant, Rudolph Maximilian Eugen, 1925-
Total energy, by R. M. E. Diamant. 1st ed., Oxford, New York, Pergamon Press, 1970,

ix, 420 p. illus., plans, 22 cm. (International series of monographs in heating, ventilation and refrigeration, v. 6)

Bibliography: p. 419-428.

This book sets out to give a comprehensive account of the methods which may be used for the production of power by small-scale equipment, and the utilization of waste heat produced. It deals with small steam turbines, open and closed cycle gas turbines, diesel and gas engines and fuel cells, as well as with methods of running small turboalternators and using the waste heat produced. There are chapters which deal with district heating practice in Europe, and total energy undertakings in the USA. Finally there is a chapter concerned with the theoretical evaluation of the economic feasibility of running a total energy plant at all.

Mathur, Satyendra P. (Eds.)

New York State Dept. of
Environmental Conservation,
Albany
State Univ. of New York,
Atmospheric Sciences Research
Center, Albany

Stewart, Ronald

Conference on the beneficial uses of thermal discharges.

Conference on the Beneficial Uses of Thermal Discharges. Proceedings.
(Held in Albany, N.Y., Sept. 17-18, 1970). New York State Dept. of
Environmental Conservation, Office of Recovery, Recycling and Reuse,
Albany. 225 pages. [n.d.]. \$10

Abs., illus., refs. for various papers. SS.

**ELECTRIC POWER PLANTS : THERMAL DISCHARGES : AQUICULTURE :
FISHERIES : AGRICULTURAL CROPS : CONFERENCES :** selected papers
cited : urban uses : New York State Dept of Environmental
Conservation.

Current trends in electric power generation are reviewed, and the
productive utilization of surplus heat is considered. Specific uses of
thermal discharges are discussed, including: aquiculture in Scotland;
mariculture in Japan; catfish farming; agricultural applications; space
heating in Iceland; greenhouse heating; agricultural-industrial and urban
uses; and combination urban-power systems.

N70-14518/ Oak Ridge National Lab., Tenn.

SPACE HEATING IN URBAN ENVIRONMENTS

A. J. Miller / In AEC Abundant Nucl. Energy May 1969
p 219 237 refs

Avail: CFSTI

A preliminary study indicates that in 1980 the heat from
a nuclear energy center in or near a large city could be used to
heat and to air-condition a large portion of the city at a cost per
unit of heat equivalent to that now incurred by district heating in
downtown commercial and high-rise apartment areas. The heat
used would be from steam out of back-pressure turbines and turbine
bleed rather than from prime steam, and thus the waste of heat
from the plant generating electricity would be reduced or largely
eliminated. Such a system would reduce both chemical pollution
of the air and thermal pollution of streams.

Author (NSA)

E. NUCLEAR

ATLANTIC GENERATING STATION

Nuclear Technology, v.22, no.2, May 1974, p.170-

Joseph A. Ashworth

1974

Studies have indicated that ~1000 MW(e) of base-load generation must be installed each year, beginning in the early 1980's, if the demand for power in New Jersey is to be met.

Nuclear power is the proper choice for these base-load installations, but in New Jersey, which has the densest population of any state in the Union, there are few remaining sites for nuclear generation stations. In addition to the dense population, the lack of available water supplies for cooling make siting of any base-load station (nuclear or fossil fired) very difficult. Even when suitable sites can be found, licensing and construction delays are steadily increasing. These problems are not unique to New Jersey; they are shared to a greater or lesser degree by many utilities operating along the heavily populated coastal areas.

Offshore siting of base-load generating stations can provide an answer to utilities beset by these problems of population, cooling water, and licensing. This approach to siting presents unique opportunities to minimize construction costs by plant standardization and "serial" manufacturing. It also poses new design problems of plant motion, operation in a marine environment, plant size envelope, and coordination of plant and site design and licensing.

SITING CONSIDERATIONS FOR FUTURE OFFSHORE NUCLEAR ENERGY STATIONS

Nuclear Technology, v.22, no.2, May 1974, p.160-

Otto H. Klepper
Truman D. Andersc

1974

The range of applicability of present nuclear plant concepts has been assessed in relation to future nuclear plant siting needs. Future electrical generating requirements indicate a major potential need for offshore stations near the populous coastal states, and a survey has been made of the availability and characteristics of offshore sites.

Consideration of population proximity, aesthetics, and water-depth requirements indicates that most of the East Coast has an adequate number of potential sites for near-term plants. However, careful planning and the deployment of large multiunit stations may be required for effective long-term use of the limited siting resource.

On the West Coast, the large population and the relatively deep water of the California region contribute to the scarcity of shallow water sites suitable for breakwater-protected offshore reactor plants, and deep-water plants may have to be developed for the area. This will require resolution of several fundamental issues, including those of mooring reliability and platform sinking. Deep-water reactor platforms must be protected from ship collision, and a promising ship-arresting system utilizing cables and drag anchors has been conceived.

PROMISE OF THE HCT REACTOR.

Mario de Bacci.

New Scientist, Jan. 5, 1974, p. 20-22.

The 'High Temperature Reactor' can run at over 900°C--and thus generate electricity more efficiently than either fossil fuelled power stations or present day reactors. It could also provide much of the "process heat" needed by heavy industry.

NUKES TO SAVE 3-BILLION GAL/OIL. Elec. Light Power, E/G Ed.; 52: No. 3, 13 Feb 1974).

The energy distributed to some highly industrialized areas in the United States from nuclear power plants is discussed. The nation's utilities would have had to burn an additional 3 billion gallons of fuel oil or more than 15 million tons of coal during the four winter months if the 40 operable nuclear plants had not been operating to supply about 5 percent of the total generating capacity in the U. S. (MCW)

Gas-Cooled Reactor Programs.

P. R. Kasten, J. H. Coobs, and A. L. Lotts.
Oak Ridge National Lab., Tenn. Mar 74, 261p
ORNL-4911 PCS7.60/MF\$1.45

Contents: HTGR head-end fuel preprocessing development; Fuel microsphere preparation development; Fuel fabrication process development; HTGR fuel recycle pilot-plant studies; Studies and evaluation of commercial HTGR fuel recycle plants; HTGR fuel element development; HTGR fuel irradiations and postirradiation evaluations; HTGR fuel chemistry fuel integrity, and fission product behavior; Reactions of HTGR core materials with steam; Fission product behavior in HTGR coolant circuits; HTGR safety program plan and safety analysis; Prestressed concrete pressure vessel development; Exchange programs; GCFR irradiation experiments; GCFR steam generator modeling studies.

THE NUCLEAR FUTURE.

Forbes, May 1, 1974, p. 22-24, 26.

Is nuclear power the answer to our energy problems? If so, what's holding it up?

ENERGY IN BRITAIN: SHOPPING FOR A NEW REACTOR. Hawkes, N. Science; 183: No. 4120, 57-59 (11 Jan 1974).

The controversy in Great Britain over the type of reactor acceptable looms. Tentatively, the LWR is the type chosen for construction, but nuclear power safety has become the issue. With an increase in electric consumption, the Central Electricity Generating Board recommends the application of the LWR for use in Britain. All designs have been considered, but the LWR costs the least and since capital cost is the determining factor, would produce the cheapest electricity. The Magnox gas-cooled graphite-moderated reactor in which natural uranium is used has served well in Britain and has its supporters. (MCW)

TITIT: Fusion Energy and other Sources of Energy
ASTRICT: Alfvén, E.
PUBLICATION DESCRIPTION: Bulletin of the Atomic Scientists, Science and Public Affairs, 30(1), 4-8

PUBLICATION DATE: 1974, January
ABSTRACT: In order to produce more energy, the development of fusion reactor technology is proceeding worldwide at a rapid pace. Part of the reason for this emphasis may be associated military support, either direct or indirect. The possible dangers of the large scale use of breeder reactors, with the huge production of plutonium, are pointed out. Intensive research efforts should be made to develop other sources of energy, such as fusion, geothermal, and solar. (JST)

A74-27020 Nuclear electric power. D. J. Rose (MIT, Cambridge, Mass.). *Science*, vol. 194, Apr. 10, 1974, p. 351-359. 23 refs.

Assessment of the prospects of nuclear electric power production in the context of other power sources and of the current energy demands and resources. The properties, economic costs and demands of nuclear plants, the U.S. uranium resources, nuclear hazards and waste disposal, breeder reactors, controlled fusion, and nuclear vs fossil power are discussed. It is pointed out that there are some reasons, both technological and social, to expect that the increase of nuclear power application for electric power generation will be even greater than had been hitherto anticipated. The impact of this increase on the economy, skilled labor, and capital investments is visualized.

SOVIET NUCLEAR POWER.

Philip R. Pryde and Lucy T. Fryde.
Environment, v.16, no.3, Apr.1974, p.26-34.

Article describes nuclear power development in the Soviet Union.

THE PROBABLE COSTS OF REACTOR SAFETY.

S. Rippon.
New Scientist, Jan.31,1974, p.252-255.

The anti-nuclear lobby is interpreting the facts and figures in such a way as to make hypothetical accidents an everyday occurrence.

Energy Policy, v.2, no.1, Mar.1974, p.18-

Environmental and social issues of site choice for nuclear power plants

Miller B. Spangler

USA legislation now requires applicants for construction permits or operating licences to provide information about environmental impacts their activities might have. In this article the author suggests that individual cost-benefit analyses, while an improvement on traditional methodology, could be more economic by establishing general rules through standardisation of plant design.

Environment, v.16, no.4, May 1974, p.14-17.

CENSORING NUCLEAR DEBATE

Sheldon Novick

Broadcast of a television documentary on the nuclear power industry has snarled the producer in legal maneuverings that threaten full airing of the public debate over nuclear power in California.

NUCLEAR SAFETY - THE PUBLIC DEBATE.

R.E. Lapp.
New Scientist, Feb.14,1974, p.394-396.

ANS Topical Meeting: Gas-Cooled Reactors: HTGR and GCFR, May 7-10, 1974, Gatlinburg, Tennessee.
P. R. Kasten, A. J. Goodjohn, and A. L. Lotts
Oak Ridge National Lab., Tenn. 1974, 580p
CONF-740561 PC\$13.60/MF\$1.45

The increasing interest in gas-cooled reactors and the increasing support for development and assessment of gas-cooled reactor power systems points up the need for disseminating pertinent information and it was in this context that the subject meeting was planned. By making these Proceedings available at the time of the meeting, information is being provided in a timely manner, and gives an up-to-date summary of gas-cooled reactor technology. The interest in gas-cooled reactors is international in character, and the papers presented represent 27 research or commercial establishments located throughout the world. The papers are grouped in six separate sections covering (1) operating experience, (2) design and economics, (3) non-nuclear components and materials technology, (4) fuel performance and fuel cycle technology, (5) advanced applications, and (6) safety technology.

ATOMIC POWER: A BRIGHT PROMISE FADING?

U.S. News & World Rept., June 10, 1974,
p.43-44,46.

From promise to performance--it's proving to be a long and difficult road for many nuclear power plants. Jack McWethy of the magazine's staff reports on an industry struggling to get on top of troublesome problems.

Compact reactor power systems. BERNINGS, J. E.
ALSON, D. G. THOMSON, R. B. VAN OSDOL, J. E.
AD(Rockwell International Corp., Canoga Park, Calif.)
MAY 1974 15 PAGES Nuclear Technology, vol.
22, May 1974, p. 237-251.
*ENERGY CONVERSION EFFICIENCY, *NUCLEAR REACTORS, *REACTOR
TECHNOLOGY, *SERVICE LIFE, *THERMOELECTRIC POWER
GENERATION, *TRICONTINENT STRIDES
BRAYTON CYCLE, CARBON MONOXIDE, COST ANALYSIS, COST
REDUCTION, ORGANIC MATERIALS, RANKINE CYCLE, SPACECRAFT
POWER SUPPLIES, SUPERCRITICAL FLOW, TECHNOLOGY ASSESSMENT
C22 A74-29956

HTGR Gas Turbine Power Plant Control and Safety Studies.
General Atomic Co., San Diego, Calif. 6 Feb 74, 96p
GA-A-12865 PC\$5.45/MF\$1.45

The research program covers the design and analysis of the control system for the High-Temperature Gas-Cooled Reactor (HTGR) gas turbine and the analysis of safety questions on the plant. The steady-state performance of the HTGR gas turbine has been analyzed with a code which includes models for the pre-cooler and dry tower. Analysis of the plant in various control modes is described, including the effects of delivering bypass flow to different points in the loop. The transient response of the power plant to various perturbations with and without control action is examined, and a basic control scheme for the plant is reported. Safety analysis of the HTGR gas turbine has been performed and includes analysis of flows following duct rupture, mechanical failures, and plant configurations to minimize the effects of such failures. The outline of a Preliminary Safety Information Document for the plant is also discussed. (Modified author abstract)

Energy Policy, v.2, no.2, June 1974, p.126-135.

Nuclear power in Canada: a different approach

F.C. Boyd

Canada's Pickering nuclear power station with a total capacity of 2000 MW demonstrates the viability of the CANDU system, which employs heavy water as moderator with natural uranium as fuel. In this article Mr Boyd describes current operating experience and the background to Canada's nuclear programme which is destined to supply about 50% of all electricity generation in that country by 2000.

NUCLEAR FUEL FABRICATION FOR COMMERCIAL ELECTRIC POWER GENERATION.

M.P. Kushner.

IEEE Trans. Power App. & Syst., v.PAS-93, no.1, Jan./Feb.1974, p.244-

The demands for electrical power generation capacity have increased significantly in recent years. This paper covers the manufacturing of uranium dioxide nuclear fuel (UO₂), for use in commercial nuclear reactors presently used for electric power generation. It explains in detail, the manufacturing and processing steps associated with the conversion of uranium hexafluoride gas into UO₂; the compacting of UO₂ pellets and the assembly of fuel rods and fuel assemblies. This paper can be described as a walking tour through a typical nuclear fuel fabrication plant.

A Survey of Unique Technical Features of the Floating Nuclear Power Plant Concept.

Directorate of Licensing (AEC), Washington, D.C. Mar 74, 114p

WASH-1304 PCS5.45/MF\$1.45

The manufacture, installation, operation, and decommissioning of floating nuclear power plants at offshore sites is examined with respect to the major technical differences between such plants and land-based nuclear power plants. Anticipated environmental effects of activities associated with offshore nuclear plants are discussed. Possible accidents, both in-plant and during the transport of radioactive materials to and from an offshore plant, are described and an initial estimate of their relative significance presented. Salient points of the survey are summarized below according to general subject area.

A74 25901 Nuclear Science Symposium, 20th, and Nuclear Power Systems Symposium, 5th, San Francisco, Calif., November 14-16, 1973. Proceedings. Symposia sponsored by IEEE, NASA, and AEC. *IEEE Transactions on Nuclear Science*, vol. NS-21, Feb. 1974, 1012 p.

Subjects considered are in the areas of position sensitive detectors, semiconductor detector materials, semiconductor detector technology, biomedical instrumentation, reactor instrumentation, nuclear instrumentation, and data acquisition and processing. Topics related to photon detection are discussed together with methods for environmental radiation measurement, aspects of environmental gamma-ray analysis, and nuclear techniques for elemental analysis. Attention is also given to operation and design experience with systems at nuclear power plants.

HIGH TEMPERATURE GAS-COOLED REACTOR AS A SOURCE OF HIGH TEMPERATURE PROCESS HEAT. The nuclear reactor has established itself as a future major supplier of electrical energy. The industrial market for other forms of energy, however, is almost as large and represents a new potential for the use of nuclear reactors. The high temperature gas-cooled reactor (HTGR) has been developed for commercial application in the electric power generation field. Since the HTGR is capable of delivering process heat in the temperature range of 1000-1500°F, it has many applications that would not be possible at the lower operating temperatures of water-cooled reactors. This paper briefly summarizes the development of the HTGR and outlines its salient technical features. Modifications to the reactor that enable it to be used as a process heat source are discussed. Specific applications are developed for coal gasification, steelmaking, and hydrogen production. 1 rd.

Quade, R.N. Gulf Gen At Co, San Diego, Calif. *Nucl Eng Des* v 26 n 1 Jan 1974 p 179-186.

S-453

HOW FAR SHOULD WE GO WITH NUCLEAR POWER.

H. Ardman.

The American Legion Magazine, June 1974, p.4-7, 42,-46.

Equal consideration has not yet been given to clean solar power. Why?

NUCLEAR POWER RISKS.

R.P. Hammond.

Amer. Scientist, v.62, no.2, Mar./Apr.1974, p.155-160.

A leading nuclear scientist takes a timely look at some of the hazards involved in the operation of atomic reactors.

MATERIALS AND DESIGN CONCEPTS OF GAS-COOLED REACTOR SYSTEMS. The family of gas-cooled reactors being developed consists of the steam-raising and direct cycle versions of the high temperature gas-cooled reactor (HTGR) for electric power generation, the hydrogen-producing HTGR for chemical process applications, and the gas-cooled fast reactor (GCFR), a high gain breeder. The aim of this paper is to describe the underlying design concepts that are common to all of these reactors and relate these design concepts to the choice of both structural and fuel materials for the wide variety of environmental conditions encountered throughout the world. Interwoven with this discussion are typical examples of the interaction of design activities and materials selection required to give a reactor system of maximum safety and reliability, favorable environmental features, and minimum cost.

Laudis, J.W. Gulf Gen At Co, San Diego, Calif; Watson, J.F. *Nuc Eng Des* v 26 n 1 Jan 1974 p 38-57.

NUCLEAR POWER PLANT ENVIRONMENTAL REPORTS.
M.J. Robinson and E.O. Smith.
IEEE Trans. Power App. and Syst., v.PAS-93, no.1, Jan./Feb.1974, p.321-

This paper discusses the environmental report requirements for nuclear power plant construction and operating permits. The current guidance furnished by the Atomic Energy Commission is discussed and the implications regarding timing and possible criticisms by the public are pointed out. Examples from current licensing and permit hearings are discussed in the context of how to minimize the conflicts that might arise.

MEETING THE CHALLENGE TO NUCLEAR ENERGY HEAD-ON. Doub, W. O. Atomic Energy Commission, Washington, DC). *At. Energy Law J.*; 15: No. 4, 238-264 (Win 1974).

The problem of what can be done to streamline the process to license and build commercial reactors is addressed. Of the 36 nuclear plants scheduled for completion before Jan 1976, 21 have been identified by FPC as high-priority projects, but their construction cannot be accelerated any further to a significant degree. Causes of schedule delays in 28 plants scheduled for 1973 operation are discussed. Actions to minimize rechecking (changes in licensing requirements) are described briefly. Time savings possible from standardized plants and designated sites are considered; use of preconstruction permit exemptions is also discussed. Steps have been taken to increase availability of regulatory information to the public and thus improve the public debate over nuclear power. (DLC)

A Technique for Environmental Decision Making Using Quantified Social and Aesthetic Values.
J. B. Burnham, M. H. Karr, G. L. Wilfert, W. S. Maynard, and S. M. Nealey.
Battelle-Pacific Northwest Labs., Richland, Wash. Feb 74, 243p
BNWL-1787 PC\$7.60/MFS1.45

A four-phase study was designed for the evaluation of social, economic and environmental tradeoffs in the analysis of nuclear plant siting options. The results of the first phase of this work are reported here. A method was devised for combining social values with techno-economic values. This technique that community judgments be measured on the same plant design criteria that are independently quantified by experts on a technical basis. The social values are used as a weighting factor for the techno-economic values.

Comparative Evaluation of Solar, Fission, Fusion, and Fossil Energy Resources, Part 3. ~~Fission~~
J. D. Clement, and W. A. Reupke.
Georgia Inst. of Tech., Atlanta. School of Nuclear Engineering. 20 Mar 74, 61p NASA-CR-138117
N74-22990/5WE PC\$6.25/MFS1.45

The role of nuclear fission reactors in becoming an important power source in the world is discussed. The supply of fissile nuclear fuel will be severely depleted by the year 2000. With breeder reactors the world supply of uranium could last thousands of years. However, breeder reactors have problems of a large radioactive inventory and an accident potential which could present an unacceptable hazard. Although breeder reactors afford a possible solution to the energy shortage, their ultimate role will depend on demonstrated safety and acceptable risks and environmental effects. Fusion power would also be a long range, essentially permanent, solution to the world's energy problem. Fusion appears to compare favorably with breeders in safety and environmental effects. Research comparing a controlled fusion reactor with the breeder reactor in solving our long range energy needs is discussed. (Author)

REPORTS FROM THE WORLD NUCLEAR POWER
STATION SITE. 1. Nucl. Eng.; 19: No. 214, 141-157 (Mar 1974).

The first of two sections of a world review giving brief reports on the status of construction or operation at sites where nuclear power stations are either being built or have recently been commissioned is presented. Part 1 covers Argentina, Austria, Brazil, Canada, Finland, France, Germany, India, Italy, Japan, Netherlands, Pakistan, Spain, (UK).

(WASH-1281-10) FUSION REACTORS. Subpanel Report X Used in Preparing the AEC Chairman's Report to the President. Kouts, H. J. C. (USAEC, Washington, D. C.).

27 Oct 1973. 297p. Dep. NTIS \$16.00.

The Subpanel concludes that a substantially increased Federal effort in the following areas of fusion energy research and development are of first importance: (a) safety, performance, and environmental research and development of light-water-reactor and gas-cooled-reactor power plants and the associated fuel cycle; (b) geological survey and exploration for uranium on both a global and national scale; (c) advanced technology programs in fuel and materials including fuel processing and recycling; and (d) liquid-metal fast breeder research, development, and demonstration. In addition, the Subpanel recommends that a vigorous technical and economic evaluation of the light-water breeder reactor be undertaken by a group including industry. Annual expenditures growing to a level of ~\$900 million per year in the late 1970's will be necessary for the orderly pursuit of the program's goals and priorities. (auth)

Nuclear engineering is an integrated program for energy and power. R.A. Fournier (Univ. Arizona, Tucson, USA). Trans. Am. Nucl. Soc. (USA), vol. 17, p. 55 (Sep. 1973). (American Nuclear Society 1973 Winter Meeting (unpublished), San Francisco, Calif., USA, 11-15 Nov. 1973).

The objectives of the program, briefly stated, are to encourage coordinated study and research in the College of Engineering, Arizona, directed toward providing optimal engineering solutions to society's energy needs. All energy sources (fossil, nuclear, geothermal, solar, etc.) and the engineering systems to convert and transfer energy are within the scope of interest. Energy management and environmental control are major considerations. Applied research and industrial interaction are given particular emphasis. The paper describes the program and reflects on the requirements of the FSE Committee's efforts in formulating and implementing the program. (no auth.)

(TID-26528, pp 131-167) SHORT-TERM NUCLEAR OPTION. Chapter III. Weinberg, A. M. (Oak Ridge National Lab., TN). Dec 1973.
In report of the Cornell workshops on the major issues of a national energy research and development program, September 14, 1973-October 17, 1973.

The USA has in operation, under construction, or firmly committed more than 150,000 MWe nuclear power to come into operation in the 1980's indicating 17 to 20 percent of the entire energy budget of the nation. To reduce the dependence on oil imports, it is stated that overall use of energy must be reduced, additional supplies of domestic oil from the ground or by conversion of coal are necessary, or substitution of energy from coal and uranium are necessary. The reactors that are available now will be replaced with breeders and controlled fusion reactors in the long haul. Data concerning uranium and uranium reserves were discussed and it was concluded that the single most vulnerable part of the nuclear enterprise is the uncertainty as to the availability of uranium ore. Availability of separate work capacity, adequacy of industrial manufacturing capacity, environmental impact, safety, and cost were reviewed. Comments on the paper are published in an appendix. (MCW)

URANIUM ENRICHMENT OUTLOOK: Hearings held Oct. 2-4, 1973 by the U.S. Joint Committee on Atomic Energy on actions necessary to insure sufficient enriched uranium supplies. (Future Structure of the Uranium Enrichment Industry, Parts I and II, available from Joint Committee on Atomic Energy, The Capital, Washington, D.C.)

TEXAS AND NUCLEAR POWER. Johnson, P. C. (Texas Medical Center, Houston). Tex. Med., 68: 81-85(Mar 1973).

Texas must look for new sources of electric power to prevent an energy crisis. Nuclear power is the most practical of the new forms of electricity. The proposal of a nuclear power plant generates considerable controversy among the citizens of the community. Much debate centers around the medical consequences of the released radioactivity. The practicing physician can help his community resolve the problem. This review is designed to give the Texas physician the information necessary to answer his patients' questions concerning nuclear power. (auth)

CONFERENCE ON THE OCEAN, NUCLEAR ENERGY, AND MAN.
April 25-27, 1973, sponsored by Amer. Nucl. Soc. & Marine Tech. Soc.

Amer. Nucl. Soc. Trans., v.16, no.1 (Suppl.),
1973, p.1-34.

SURVEY OF THE MARKET FOR NUCLEAR POWER IN DEVELOPING COUNTRIES. Falls, O. B. (International Atomic Energy Agency, Vienna). Energy Policy, 1: No. 3, 225-242(Dec 1973).

The long-range economic justification for nuclear power plants in 14 of the developing countries was studied and analyzed from a survey in 1972-1973 by the IAEA. Some computer programs were developed for the survey. Concluding facts on the market survey show that, during the period 1980-1989, there is essentially no market for small nuclear power units of sizes 300 MW and smaller. There is a substantial market for 600 MW and 800- to 1000-MW sizes. The total thermal power plant market for the nuclear portion is less than 50% up to 1982; 70 to 75% in 1982-1984; 80 to 95% in 1985 to 1989. Once nuclear plants are indicated for a given country, they will continue so in the future. After the larger sizes (600 MW and over) become justified, substantial changes in the values of the economic parameters (oil prices or discount rates) will have little effect on the total nuclear plant market since essentially all units will prove to be nuclear from that point into the future. (MCW)

(TID-8200-R29) NUCLEAR REACTORS BUILT, BEING BUILT, OR PLANNED IN THE UNITED STATES AS OF DECEMBER 31, 1973. (USAEC Office of the Assistant General Manager for Energy and Development, Washington, D. C.). 1973, 42p. Dep. NTIS \$4.00.

Information is tabulated on nuclear reactor and critical assembly facilities in operation, shut down, under construction, or planned. The data include name, owner, location, type, power, and startup date. (JWR)

FLOATING REACTOR: 'CRISIS SOLUTION?'

G.D. Friedlander

IEEE Spectrum, Feb. 1973, p. 44-51

In addition to minimizing thermal pollution, there are other advantages to ocean siting.

ENVIRONMENTAL IMPACT OF A FLOATING NUCLEAR PLANT. Nutant, J. A. Pub. Util. Forum.; 91: No. 13, 38-40 (21 Jun 1973).

A floating nuclear power plant will have minimal environmental impact upon marine biology, land- and water-use considerations, and aesthetic quality. While some impact is inevitable, it is expected to be well within the bounds of environmental restraints. Potential damage from chemical and thermal discharges are expected to be minimized by built-in safety precautions. (auth)

ENVIRONMENTAL CHALLENGES AND NUCLEAR

FUELS. Davis, W. K. (Bechtel Power Corp., San Francisco, CA). Chem. Eng. Progr.; 69: No. 6, 49-53 (Jun 1973).

Expansions in the nuclear programs will not in themselves solve the energy crisis by 1985 or even 1990, but could have a significant part in alleviating it. Nuclear power must be mainly applied to the generation of electric power and some large-scale industrial heat uses. The supplies of nuclear fuels at reasonable prices must be considered adequate, in view of the availability of breeder technology when needed—that will vastly expand the equivalent energy content of nuclear fuels. It appears that the environmental impact of nuclear power plants will be less than other power plants, except for the higher rejection of heat to cooling water per unit of power produced. The problems due to radioactivity emissions from nuclear power plants are not significant. The long-range storage of high-level radioactivity cannot be considered an unmanageable problem or one with significant cost or environmental impacts. The long-range development of the fusion reactor, along with the breeder reactor, will give unlimited energy resources. The ability to supply all energy needs from nuclear sources will depend on further inventions and developments in the storage and transport of energy (such as automobiles, aircraft, etc.). (MCW)

ROLE OF NUCLEAR ENERGY IN PRESERVING ENVIRONMENTAL VALUES. Balzhiser, R. E. (Office of Science and Tech., Washington, DC). Pub. Util. Forum.; 91: No. 3, 19-22 (1 Feb 1973).

The harmonious co-operation of the White House, Congress, the energy industry, environmental and consumer groups, and the general public will be needed to solve the energy problems. An understanding of the interrelationship among energy, environment, and economics is essential. An Office of Science and Technology energy review has indicated that nuclear power is the most viable energy form to meet future needs. (auth)

Index to Nuclear Safety: A Technical Progress Review by Chronology, Permuted Title, and Author Vol. 1, No. 1, through Vol. 13, No. 6—A complete index to all articles that have appeared in the Nuclear Safety journal. A KWIC (key word in context) index is used in the Permuted Title section while two other sections detail a chronological list of articles by volume and a complete author index. 1973. 143 pp. PC \$8/MF \$8 order ORNL-NSRC-107/G

TITLE: Siting Nuclear Power Plants in California:

The Near-Term Alternatives

AUTHOR: Goldsmith, R.

CORPORATE AUTHOR: California Institute of Technology, Environmental Quality Laboratory

ADDRESS: Pasadena, CA 91109

PUBLICATION DESCRIPTION: ECL report No. 8, 82 p., 36 references

PUBLICATION DATE: 1973, July

SPONSOR: National Science Foundation, RANN Program

ABSTRACT: The various possible locations for nuclear power plants in California are

examined. It is concluded that there are a few areas along the seacoast that are acceptable, and also several inland sites in more or less desert country. There is very little cost advantage of coastal siting. Inland sites are technically and economically feasible and offer a better chance for expeditious site selection and licensing. (JRC)

AVAILABILITY: (82-50)

1973

1973

TITLE: The Potential Radiological Implications of Nuclear Facilities in the Upper Mississippi River Basin in the Year 2000
CORPORATE AUTHOR: U.S. Atomic Energy Commission, Division of Reactor Development and Technology
ADDRESS: Washington, DC
PUBLICATION DESCRIPTION: Report No. WASH-1209, 240 p., 159 references

PUBLICATION DATE: 1971, January
ABSTRACT: This study considers the radiation of the potentially received by the population of the UMR (Upper Mississippi River Basin) study area which might result from the operation of nuclear power and fuel reprocessing facilities in the year 2000. Those facilities which were assumed to be operating in that year, in the UMR study area and the surrounding "air envelope" region, included an aggregate nuclear generating capacity of 356,000 Mw (assumed to consist of 26,000 Mw of BWRs, 138,000 Mw of PWRs, and 172,000 Mw of LWRs), plus nine nuclear fuel reprocessing facilities (8 plants of 5 tonnes per day capacity plus the existing 1 tonne/day Morris facility). Radionuclide releases from these facilities were estimated, transport through the region was modeled, and the resulting concentrations were used to calculate radiation exposure to the 29.1 million inhabitants of the UMR study area. The results of the study of the UMR based on the selected radiation waste treatment systems showed that, on the average throughout the region, the potential radiation an average individual could receive in the year 2000 would be increased by roughly 0.2 millirems/year because of the presence of nuclear facilities. This may be brought into perspective by realizing that it is only slightly more than one-tenth of one percent of the roughly 180 millirems/year received from natural sources, about two-tenths of one percent of that received from medical and dental sources such as diagnostic X-rays, and only one percent of that received from other manmade sources such as television set components and luminous watch dials. (Auth, from Summary)

AVAILABILITY: GPO

(NNL-17887) IMPACT OF NUCLEAR POWER ON THE PUBLIC: THE AMERICAN EXPERIENCE. Bond, V. P. (Brookhaven National Lab., Upton, N.Y.). Jan 1973. 73p. Dep. NTIS \$5.75.

Lecture at the Kernforschungsanlage, Juelich, West Germany. The American experience with respect to electrical power production, usually only discusses the risks and benefits of one power source (nuclear) and one possible hazard (radiation from routine releases). Discussions and analyses now deal with all feasible power sources, as well as the costs and benefits associated with fuel production, the operation of such sources, fuel transportation, and waste disposal. A number of attempts have been made to assess the total benefits and risks of nuclear versus fossil fuel plants. Data have concluded that the overall cost in terms of possible damage to health and the environment is least for nuclear power, next for oil, and the greatest for coal-fired plants. In addition to developing a long-lasting energy supply, such as through the nuclear approach, attention must be given to devising means of utilizing the limited fossil fuels, especially coal, in a manner that is much less contaminating and more efficient than at present. (JCW)

Personnel Involved in the Development of Nuclear Standards in the United States, 1972—Here's a directory set up in three different ways to make it easier for you to identify personnel involved in the development of nuclear standards in the U.S. It's organized by personal name, company name, and standards—generating organizations and committee titles. Includes a key word in context index of all standards activity titles keyed to the three data sections. 1973. 491 pp. PC \$15/MF \$15 order ORNL-NSC-108/G

73V44429 1973 ISS OC ID195.E4A45 1973 301.31 LC-73-178276
 NUCLEAR POWER AND THE ENVIRONMENT: QUESTIONS AND ANSWERS.

AMERICAN NUCLEAR SOCIETY.
 HINSDALE, ILL. 64 P. ILLUS. 29 CM.
 INCLUDES BIBLIOGRAPHICAL REFERENCES.
 LC ATOMIC POWER-PLANTS -- ENVIRONMENTAL ASPECTS -- MISCELLANEA.
 MAIN-CORP TRACE-TITLE# CATLG BY-LC

S-445

SCIENTIFIC FACTS BEHIND THE HASSLE OVER ATOMIC ENERGY SAFETY.

E. Edelson.

Popular Science, Sept. 1973, p. 78-81, 112, 114.

We need more electrical energy desperately, and some experts are boosting nuclear plants as the best bet. But critics insist that the risk is too great.

NUCLEAR POWER: THE ELECTRIC INDUSTRY'S

BEST HOPE FOR THE FUTURE. Zittlau, W. A. (San Diego Gas and Electric Co., CA). Pub. Util. Fortn., 91: No. 7, 110(29 Mar 1973).

The advocacy of the use of natural gas as a primary source of energy for air pollution control is unthinkable, when there is nuclear power available. Fossil fuels are too precious and exploitable. The use of natural gas is indiscriminate most times for inferior purposes. The use of natural gas as boiler fuel is most inefficient. Rapid expansion and use of nuclear energy for power generation is urgent. Other alternative sources of energy for power generation include fusion power, solar energy, and geothermal resources. (JCW)

WHAT'S HOLDING UP NUCLEAR POWER?

U.S. News & World Rept., Nov. 26, 1973, p. 23-25.

At a time when the need for additional nuclear plants was never so pressing, Dr. Ray, Chairman of AEC, assess the prospects of meeting U.S. energy needs.

N74-15257 Geological Survey, Washington, D.C.

NUCLEAR FUELS: URANIUM

c17

Warren I. Finch, Arthur P. Butler, Jr., Frank C. Armstrong, and Albert E. Weissenborn. In *its US Mineral Resources* 1973 p 458-468 refs (For availability see N74-15214 06-18)

Uranium is an important energy resource, and even though the demand for its use in nuclear-powered electrical generators was only moderate in 1972, near-future needs are expected to be very great. In the United States, large exploitable deposits are found chiefly in sandstone and associated rocks. In other parts of the world, large deposits are mainly in quartz-pebble conglomerate of early Precambrian age and in veins. Domestic resources recoverable at present prices totaled about 273,000 tons of U3O8 at the end of 1971, and the total for all countries reporting resources is about 1.6 million tons of U3O8. These supplies are sufficient to last into the 1980's. Needs beyond 1980 are so great that tremendous efforts in exploration, and research in ore-finding techniques, will be required to discover new recoverable resources. Author

N74-15258 Geological Survey, Washington, D.C.

NUCLEAR FUELS: THORIUM

c17

Mortimer H. Stantz and Jerry C. Olson. In *its US Mineral Resources* 1973 p 468-476 refs (For availability see N74-15214 06-18)

Although the current demand for thorium is small, future needs may be large as a fuel for nuclear generators. The occurrence of thorium is widespread, and large deposits are found in beach and fluvial placers, veins, sedimentary rocks, alkalic igneous rocks, and carbonatites. Thorium has been produced principally from monazite from beach and fluvial placers, although in the 1950's and early 1960's monazite from a unique vein in South Africa was the chief source. In the early 1970's monazite was recovered principally as a byproduct of titanium or tin mining in India, Brazil, Australia, and Malaysia. A large thorium resource in the conglomerates at the Elliot Lake uranium mines, Canada, could become an important byproduct if demand increases. Thorium resources are not well known because of the small demand, but are sufficient for many years in the future. The development of a variable domestic thorium mining industry is dependent on a large enough increase in demand to exceed the amount obtainable as byproducts from other types of deposits. Author

COSTS AND BENEFITS OF NUCLEAR POWER.

J. Dunster.

New Scientist, Oct. 18, 1973, p. 192-194.

(COO-2260-3) ELECTRICAL POWER GENERATION: COMPARATIVE RISKS AND BENEFITS. Final Report, August 6, 1973-August 10, 1973. A One-Week Workshop for High School Science Teachers. Carbon, M. W.; Hartwig, K. T. (Wisconsin Univ., Madison (USA)). 16 Aug 1973. Contract AT(11-1)-2260. 37p. Dep. NTIS \$4.00.

A live-in type workshop available for academic credit covering basic nuclear power generation and the tradeoffs and problems that exist between nuclear power and alternative means to generate electricity was held for 37 high-school teachers at the Madison campus for the University of Wisconsin. Significant improvements over last year's program included the distribution of a large amount of information and the distribution of two minicourses out-lines on the subject of power and the environment entitled: "The Environmental Impact of Electrical Power Generation: Nuclear and Fossil" prepared by the Pennsylvania State Dept. of Education, and "Science III Matter - Energy Interactions in Natural Systems" prepared by Carl Pfeiffer of Monona Grove High School, Monona, Wisconsin. (MCW)

FUTURE GROWTH OF NUCLEAR POWER. Part 2. Choices and Obstacles. Surrey, A. J. (Univ. of Sussex, Brighton, Eng.). Energy Policy; 1: No. 3, 208-224(Dec 1973).

Choices and obstacles in the future development of nuclear power technology are discussed, with examination of technical options, public safety, and economics. A major difficulty is to establish a realistic basis for comparison, for nuclear plants are relatively capital-intensive while fossil-fuel plants are fuel-intensive. Once built, a nuclear plant is normally utilized to the maximum, because its running costs are only a fraction of those of even the most efficient fossil-fuel plant. The basic sources of uncertainty are safety and future technical progress and it is these aspects that will jointly determine the long-term acceptability and competitiveness of nuclear power. (43 references) (MCW)

(COO-2260-2) ELECTRICAL POWER GENERATION: COMPARATIVE COSTS AND BENEFITS. A One-Week Workshop for High School Science Teachers. Final Report. Carbon, M. W.; Hartwig, K. T. (Wisconsin Univ., Madison). 28 Feb 1973. Contract AT(11-1)-2260. 17p. Dep. NTIS \$3.00.

A workshop covering basic nuclear power generation and the tradeoffs and problems that exist between nuclear power and alternative means to generate electricity was held between August 7-11, 1972 for forty high-school teachers at the Madison campus of the University of Wisconsin. A feedback conference was held January 13, 1973. A summary and evaluation of the conference were made. (JCV)

FUTURE GROWTH OF NUCLEAR POWER. Part 1. Demand and Supply. Surrey, A. J. (Univ. of Sussex, Brighton, Eng.). Energy Policy; 1: No. 2, 107-129(Sep 1973).

Uncertainty surrounds the development of nuclear power in the 1980's. Projections of growth suggest that the nuclear generating capacity of the non-Communist countries will reach 250,000 to 300,000 MW(e) in 1980, 500,000 to 650,000 MW(e) in 1985, and 900,000 to 1,200,000 MW(e) in 1990. A serious reactor failure or increasing public concern for siting and safety could be detrimental. The market structure of the nuclear plant supply is evolving rapidly. Manufacturing lead times are long and orders are irregular. Nuclear fuels have a more complex supply structure than the plants. The USA has yet to decide when to build additional enrichment facilities and who should control them. (MCW)

73V14318 19-- ISS 00 TK9202.843 1973 C-470066-25-3 621.48

LC-72-13693

A/BENNET, DONALD JOHN.

THE ELEMENTS OF NUCLEAR POWER BY D. J. BENNET.

WILEY NEW YORK, XI, 207 P. ILLUS. 25 CM.

"A HALSIED PRESS BOOK."

LC NUCLEAR REACTORS. ATOMIC POWER-PLANTS.

MAIN-AUTH TRACE-IITL# CAILG BY-LC

/ / COPYR IGT

1973

TITLE: Commercial Nuclear Power Plants
CORPORATE AUTHOR: Southern Nuclear Engineering Inc.

ADDRESS: P.O. Box 10, Danedin, PL 33528
PUBLICATION DESCRIPTION: Edition No. 6, 60 p.
PUBLICATION DATE: 1973, October
ABSTRACT: This booklet provides tables of basic information on nuclear power plants in operation and under construction in the United States. The power plants are listed alphabetically by utility. The information includes: location; type of reactor; type of containment; cooling system; reactor supplier; turbine-generator manufacturer; engineering and construction firms; dates of announcement, ABC application, construction permit, operating license, first time critical, and commercial operation; and construction progress. (NPO)
AVAILABILITY: Southern Nuclear Engineering Inc., P.O. Box 10, Danedin, PL 33528, (\$2.00 per copy for bulk orders, no charge for single copies)

Audiotape

CN-129, 601, Nos. 514 & 537. / (1973)
MEN AND MOLECULES. SIDE I: FUSION AND FISSION: AN APPRAISAL. James L. Tuck. (Radio Series 514). SIDE II: THE PROSPECTS FOR ENERGY. M. King Hubbert. (Radio Series 537). (1973). (Audiotape).

American Chemical Society
American Chemical Society
American Chemical Society

Radio Series 514
Radio Series 537

Power sources, Nuclear
Thermonuclear equipment
Audiotapes - Power sources, Nuclear

L99,252

73V14398 1973 ISS 00 TK9202.K7B 62L48 LC-72-14096

A/KULJIAN, HARRY A.

ENERGY THROUGH NUCLEAR REACTORS, BY HARRY A. KULJIAN AND ANDREW W. KRAMER.

SAINT JOSEPH'S COLLEGE PHILADELPHIA,
BIBLIOGRAPHY P.

LC NUCLEAR REACTORS. NUCLEAR PHYSICS.

ADDED KRAMER, ANDREW WILLIAM, 1893- JOINT AUTHOR.

MAIN-AUTH TRACE-IITL*AUTH# - CALLG BY-LC

214

1973

US ENERGY OUTLOOK. Nuclear Energy Availability. Washington, DC: National Petroleum Council (1973). 159p.

The National Petroleum Council's Initial Appraisal assumed a continuation of the general government policies and economic climate in effect in 1971. In this context, installed nuclear electric power generating capacity was projected to attain a level of 150,000 megawatts (MWe) in 1980 and 300,000 MWe in 1985. In order to assess the capability of the nuclear industry to provide more energy and to take into account possible changes in government policies and the economic climate, this study has developed projections for a maximum growth rate of nuclear electric power (Case I, 450,000 MWe installed in 1988), a minimum growth rate (Case IV, 240,000 MWe in 1988), and two intermediate growth rates (Case II, 375,000 MWe in 1985 and Case III, 300,000 MWe in 1985). The four different rates of growth were then further projected to the year 2000 in order to establish the requirements for the development of forward reserves of uranium and thorium in 1985 and to establish a basis for qualitative analysis of trends in supply of nuclear energy to the end of the century. (auth)

N74-15381# New South Wales Univ., Kensington (Australia). School of Nuclear Engineering.

ENERGY SITUATION AND NUCLEAR POWER

Z J Nov 1973 29 p refs

(NP-19838) Avail: AEC Depository Libraries \$3.50

A survey of the characteristics and potential applications of nuclear reactors for electricity and process heat production is presented, against a background of increasing global energy demand, fossil and nuclear fuel reserves, and environmental problems of power production. The large scale adoption of nuclear power using breeder reactor systems appears inevitable in the long term, but complex and rapidly changing interaction between local and global factors makes projections for any specific country increasingly difficult.

Author (NSA)

A74-13234 * # Satellite nuclear power station: An engineering

analysis. J. R. Williams, J. D. Clement (Georgia Institute of Technology, Atlanta, Ga.), R. J. Rosa, K. D. Kirby, and Y. Y. Yang. Research supported by NASA; Grant No. NGR-11-002-145. Atlanta, Ga., J. R. Williams, Georgia Institute of Technology, 1973. 143 p. 41 refs. **also NTIS-28653 #**

A nuclear-MHD power plant system which uses a compact non-breeder reactor to produce power in the multimewatt range is analyzed. It is shown that, operated in synchronous orbit, the plant would transmit power safely to the ground by a microwave beam. Fuel reprocessing would take place in space, and no radioactive material would be returned to earth. Even the effect of a disastrous accident would have negligible effect on earth. A hydrogen moderated gas core reactor, or a colloid-core, or NERVA type reactor could also be used. The system is shown to approach closely the ideal of economical power without pollution. V.P.

TK Intersociety Energy Conversion Engineering Conference, 8th Philadelphia, Pa., 1973.

2896 Proceedings. New York, American Institute of

.155 Aeronautics and Astronautics [1973]

847 p. illus. 29 cm.

Held at: University of Pennsylvania, Philadelphia, Pa., August 13-16, 1973.

Sponsored by: American Institute of Aeronautics and Astronautics [and others]

A Combined Nuclear and Hydrogen Energy Economy - A Long Term Solution to the World's Energy Problem - L. A. BOOTH, J. D. BALCOMB,

F. J. EDESKUTY..... 396

Exploratory Study of Several Advanced Nuclear-MHD Power Plant Systems -

J. R. WILLIAMS, R. J. ROSA, Y. Y. YANG, J. D. CLEMENT..... 558

The Satellite Nuclear Power Station: An Option for Future Power Generation -

J. R. WILLIAMS, J. D. CLEMENT..... 566

(NP-19854) DEVELOPMENT OF THE NUCLEAR-ELECTRIC ENERGY ECONOMY. Ross, P. N. (Westinghouse Electric Corp., Pittsburgh, Pa.). Jun 1973. 18p.

A brief, graphical (34 figures) review is presented of energy sources of the world and USA. Oil and natural gas reserves are shown to be extremely limited, leaving coal as the basis for the petroleum and petrochemical industry. Patterns of energy use in the industrial and residential sectors are analyzed. It is proposed that the development of a nuclear-electric energy economy is the only viable long-term solution to the energy problem. The impact of this proposition on the electric power industry and on future needs for oil and gas is described. (DLC)

TITLE: Nuclear Energy: How Soon? How Safe?

AUTHOR: Lape, R.V.

ADDRESS: Alexandria, VA

PUBLICATION DESCRIPTION: Consulting Engineer, 80(3), 156-163

PUBLICATION DATE: 1973, March

ABSTRACT: Nuclear reactors used for electric power generation are described in some detail, including boiling water reactors, pressurized water reactors, high temperature gas cooled reactors, and the liquid metal fast breeder reactor. Also discussed are reactor control and nuclear safety systems, radioactivity build-up, spent fuel reprocessing, and radiation hazards. In spite of the risks, the U.S. seems to have no choice other than nuclear power plants in the short term. (NPG)

QC
792
.155

Inglis, David Rittenhouse, 1905.
Nuclear energy: its physics and its social
challenge. Reading, Mass., Addison-Wesley

PUBLICATION DATE: 1973

ABSTRACT: The purpose of the book may be summarized by the following sentence in the Preface: "Intelligent social choices must be based on technical as well as political understanding." The introduction to the book is entitled "Man's Growing Use of Power". The nine chapters have the following titles: Basic Physical Ideas - Force and Energy; Some Features of a Power Plant; Atoms, Molecules and Nuclei; Nuclear Reactors as a Power Source; Effects and Uses of Radioactive Products; Control of Fissile Materials; Other Possible Power Sources and Future Needs; Nuclear Explosives; and Constraints on the Arms Race. Some basic physics is discussed in appendices, including kinetic energy, mechanics of atoms, behavior of nucleons in nuclei, and elastic collisions. (MP6)
AVAILABILITY: Addison-Wesley Publishing Co., Inc. (sa.95 paperback, \$6.95 cloth cover)

QC
750
.V34

Vandenbosch, Robert.
Nuclear fission, by Robert Vandenbosch
and John R. Huizenga. New York, Academic
Press, 1973.
xii, 422 p. illus. 24 cm.

NUCLEAR ENERGY: THE SOURCE FOR THE FUTURE. Lewis, W. B. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Naturwissenschaften; 60: No. 11, 501-506 (Nov 1973).

Following an estimate of the future energy needs of the whole world, a survey is given of future processes of nuclear energy conversion, taking the CANDU reactor currently most used in

Canada as a reference basis. The following types of conversion methods are reviewed: fast breeders, thermonuclear energy sources, neutron sources, and fusion reactors. (UA/OB) (GE)

Plowshare Technology Assessment. Energy Development Trends.

John C. Bellamy, and Michael C. Penz.
Western Interstate Nuclear Board. Lakewood, Colo. Jan 73.
29p NSF-RA-G-73-013
PB-231 039/9WE PC\$4.50/MF\$1.45

An analysis of probable future needs for energy in relation to potential sources of energy and environmental concerns is used to postulate how those needs might best be served. It is thereby postulated that nuclear heating plants can well be developed to serve most of our needs for heat and electrical energy in stationary locations, and that fossil fuels can thereby well be conserved largely for propelling vehicles. It is thereby also seen that nuclear explosives are likely to be needed to extend the use of natural gas for stationary heating needs during the transitional period. (Author)

REACTOR AS A SOURCE OF INDUSTRIAL ENERGY.

Anderson, T. D.; Michel, J. W. Oak Ridge Nat. Lab. Rev.; 6: No. 3, 19-23 (Feb 1973).

The ideal requirement for nuclear power plants to have a role in the future supply of industrial energy will be one large industrial consumer with accompanying small industrial energy users. Nuclear power plants would be operated as dual-purpose plants supplying electricity to a power grid and process energy for local use. The plant could offer overall savings and relieve the demand for fossil fuels and the environmental problems associated with them. Obstacles to industrial nuclear energy are: (1) the time required to construct a nuclear plant is at present four to seven years longer than the time required to build most industrial plants; (2) the planning of nuclear plants for industry will in most cases involve a utility and one or more private companies that presents organizational problems; and (3) the siting, safety, and environmental considerations for nuclear plants and some industrial plants may be conflicting. (MCW)

TITLE: The Nuclear-Power Rebellion, Citizens vs. the Atomic Industrial Establishment

AUTHOR: Lewis, R.S.

PUBLICATION DESCRIPTION: Viking Press, Inc., 625 Madison Ave., New York, NY 10022, 313 p. book

PUBLICATION DATE: 1972

ABSTRACT: This book reviews the role of the Atomic Energy Commission in promoting, and citizens in opposing, the use of nuclear energy for electric power, constructing canals, stimulating oil and gas wells, and creating underground storage chambers for gas. This is not an impartial statement of the issues. The author feels that concerned citizens are the only real challenge to a reckless nuclear-energy policy promoted by the "Atomic Industrial Establishment". (MP6)

AVAILABILITY: Publisher or bookstores (\$7.95)

N73-15693*# National Aeronautics and Space Administration.
Lewis Research Center, Cleveland, Ohio.

EMERGING NEEDS FOR MOBILE NUCLEAR POWER-PLANTS

John L. Anderson 1972 39 p refs Presented at Winter Meeting of the Am. Nucl. Soc., Washington, 12-17 Nov. 1972 (NASA-TM-X-68164; E-7224) Avail: NTIS HC \$4.00 CSCL 18E

Incentives for broadening the present role of civilian nuclear power to include mobile nuclear power plants that are compact, lightweight, and safe are examined. Specifically discussed is the growing importance of: (1) a new international cargo transportation capability, and (2) the capability for development of resources in previously remote regions of the earth including the oceans and the Arctic. This report surveys present and potential systems (vehicles, remote stations, and machines) that would both provide these capabilities and require enough power to justify using mobile nuclear reactor power plants. Author

TITLE: Combined Nuclear Gas Turbine Power and Desalination Plant

AUTHOR: Singer, P.M.; Kase, J.M.
CORPORATE AUTHOR: Gulf General Atoms' Co.
PUBLICATION DESCRIPTION: Paper 729202 presented at 7th Intersociety Energy Conversion Engineering Conference 1972 held at San Diego, CA, published in Proceedings p. 1299-1308

PUBLICATION DATE: 1972, September
ABSTRACT: The features of a combined high-temperature gas-cooled reactor (HTGR) gas turbine electric generating and saltstage flash (NSF) desalination plant are described. The desalination plant utilizes the reject heat from the HTGR gas turbine plant and thereby obtains its thermal energy requirement at essentially zero cost. As a result, the cost of desalted water is decreased by approximately 80% for plant sizes of about 100 million gallons per day (MGD). A desalination plant of nearly 90 MGD can be coupled to a standard size HTGR gas turbine plant with an output of 100 Mw(e) using conventional NSF plant designs. By utilizing a parallel train brine crossover concept, an NSF plant with a capacity of nearly 160 MGD can be coupled to the same HTGR gas turbine plant with a further decrease in water cost. (auth)

AVAILABILITY: Entire proceedings available from American Chemical Society, 1155 16th St. N.W., Washington, DC 20036

A73-18028
Electrical and isotope power from space for terrestrial use. T. B. Taylor (International Research and Technology Corp., Washington, D.C.). (New York Academy of Sciences, Conference on Planetology and Space Mission Planning, 3rd, New York, N.Y., Oct. 28-30, 1970.) New York Academy of Sciences, Annals, vol. 187, Jan. 25, 1972, p. 420-426.

The concept of an orbital facility for converting solar energy to stored fission energy for use in terrestrial power plants is reviewed in terms of overall system parameters and economics. It is suggested that the concept is worth studying in considerably greater detail. M.V.E.

TITLE: The Direct-Cycle Nuclear Gas Turbine with Economical Dry Air Cooling

AUTHOR: Kase, J.M.; Morse, B.C.; Schoene, T.B.
CORPORATE AUTHOR: Gulf General Atomic Co.
ADDRESS: San Diego, CA
PUBLICATION DESCRIPTION: Paper presented at American Power Conference, Chicago, IL, April 18-20, 1972, included in Vol. 38, 512-520

PUBLICATION DATE: 1972
ABSTRACT: The application of dry air cooling has not been used in solving the problem of disposal of waste heat generated by large electric power stations because of the large expense involved. However, dry air cooling has the following three characteristics which can be highly desirable in certain situations: wider selection of possible plant sites; no requirement for makeup water; and the elimination of secondary problems such as fogging, snowing, and icing associated with evaporative systems. Therefore, the nuclear gas turbine will become increasingly more important to the electric power production industry as plant siting problems multiply. Using existing proved gas-cooled reactor technology, the nuclear gas turbine can be developed before the necessary natural water resources and most desirable plant sites are gone. By utilizing the nuclear gas turbine, power plants using dry air cooling can not only provide power at a cost comparable or less than present plants using wet cooling; they also can provide power which will be nearly environmentally neutral. (DCH)
AVAILABILITY: Conference Director, American Power Conference, Illinois Institute of Technology, Technology Center, Chicago, IL 60694 (\$20.00)

United Engineers and Constructors inc. 1000-MWE CENTRAL STATION POWER PLANTS INVESTMENT COST STUDY. Washington, U.S. Atomic Energy Commission, Division of Reactor Development and Technology, 1972. 4 v. in 1.

Prepared for the U.S. Atomic Energy Commission, Division of Reactor Development and Technology, Contract no. AT (30-1)-3032.

1972

1972

Indexed Bibliography on Nuclear Facility Siting—This bibliography contains 900 abstracts pertaining to various phases of siting; for example: Design, Operation, Environment, Population, Seismicity, Weather, Safety Features, and other aspects of the plant and its site. About one-third of the abstracts are concerned with the various reports, questions and responses that arise during the licensing of a nuclear plant. Keyword and author indexes and a key word in context (KWIC) listing of titles are provided to simplify use of this publication. 1972. 278 pp. PC \$10/MF \$10 order ORNL-NSIC-105/G

Indexed Bibliography on Environmental Monitoring for Radioactivity—Contains 850 abstracts on the subject and includes background material to put the problem in broad perspective. Lists pertinent references for a general environmental monitoring program emphasizing the normal operation of a nuclear facility and to exclude most aspects of personnel monitoring. 1972. 319 pp. PC \$10/MF \$10 order ORNL-NSIC-101/G

73V45252 19-- ISS 00 TK1078.N83 1972 621.483 LC-73-186654
NUCLEAR POWER AND THE PUBLIC. EDITED BY HARRY FOREMAN.
ANCHOR BOOKS, GARDEN CITY, N.Y., XXVI, 371 P. ILLUS. 19 CM.
SCIENCE STUDY SERIES, S68 \$4.50 BASED ON A SYMPOSIUM HELD AT THE
UNIVERSITY OF MINNESOTA, OCT. 10-11, 1969. INCLUDES BIBLIOGRAPHIES.
LC ATOMIC POWER-PLANTS -- CONGRESSES. RADIOACTIVITY -- PHYSIOLOGICAL
EFFECT -- CONGRESSES.
ADDED FOREMAN, HARRY, 1915- ED. MINNESOTA. UNIVERSITY.
MAIN-TITL TRACE-SEPS*CCRP*AUTH* CATLG BY-LC
/ / COPYRIGHT

74V11303 1972 ISS 00 TK1078.C57 1972 621.4832 LC-73-621632
CONFERENCE ON UNIQUE SITING CONCEPTS FOR NUCLEAR POWER PLANTS.
CONFERENCE ON UNIQUE SITING CONCEPTS FOR NUCLEAR POWER PLANTS,
SACRAMENTO, CALIF., 1972.
SACRAMENTO? 147, 42 L. ILLUS. 29 CM.
COVER TITLE. AT HEAD OF TITLE JOINT COMMITTEE ON ATOMIC DEVELOPMENT
AND SPACE, CALIFORNIA LEGISLATURE. INCLUDES BIBLIOGRAPHICAL REFERENCES.
LC ATOMIC POWER-PLANTS -- LOCATION -- CONGRESSES.
ADDED CALIFORNIA. LEGISLATURE. JOINT COMMITTEE ON ATOMIC DEVELOPMENT
AND SPACE.
MAIN-MEET TRACE-CORP* CATLG BY-LC

74V29915 1972 ISS OC TK1078.L57 C-831110-78-3 621.483 LC-77-185989
 A/LISH, KENNETH C. A/1915-
 NUCLEAR POWER PLANT SYSTEMS AND EQUIPMENT, BY KENNETH C. LIST.
 INDUSTRIAL PRESS NEW YORK, VII, 183 P. ILLUS. 26 CM.
 LC ATOMIC POWER-PLANTS -- EQUIPMENT AND SUPPLIES.
 MAIN-AUTH TRACE-IIL* CAILG BY-LC

1972

1972

TITLE: International Conference on Nuclear
 Solutions to World Energy Problems
 CORPORATE AUTHOR: American Nuclear Society Inc.
 ADDRESS: 288 East Ogden Ave., Hinsdale, IL 60521
 PUBLICATION DESCRIPTION: Proceedings of the
 Plenary Sessions held November 13-17, 1972,
 Washington, DC, 358 P.
 PUBLICATION DATE: 1972
 SPONSOR: Atomic Industrial Forum: American
 Nuclear Society
 ABSTRACT: Twenty-nine papers were presented at
 this conference, covering the areas of
 Nuclear Energy and the Quality of Life, Fast
 Breeder Reactors, Safety and Siting of
 Established Power Reactor Types, Fuel Cycle,
 Thermal Reactor Power Systems, Fusion Reactor
 Engineering, and Workable International
 Safeguards. (JNC)
 AVAILABILITY: American Nuclear Society (\$32.00)

Amer. Nuc. Soc. Trans., v15, no.2, Nov.1972.

PROTECTION OF THE PUBLIC FROM RADIOACTIVITY PRODUCED IN NUCLEAR POWER REACTORS.

T.H. Pigford.

IEEE Trans.Nuc. Sci., v.NB-19, no.1, Feb.1972,
 p15-26.

The possible and potential risks to the public
 due to radioactivity generated in nuclear power
 plants and the means of protecting the public from
 those risks are analyzed in this paper.

TITLE: Nuclear Power 1973-2000
 CORPORATE AUTHOR: U.S. Atomic Energy Commission,
 Office of Planning and Analysis, Forecasting
 Branch
 PUBLICATION DESCRIPTION: Report NC. WASH-1139
 (72), 82 p.

PUBLICATION DATE: 1972, December 1
 ABSTRACT: A new forecast of the growth of nuclear
 power in the United States and the rest of
 the world has been prepared for use in AEC
 production planning and for other purposes.
 This forecast includes a revision and
 updating of the information presented in the
 AEC's 1971 forecast, WASH-1135 (Rev. 1), and
 an extension of the forecast through the year
 2000. It represents the current evaluation
 of domestic and foreign growth trends in
 nuclear power, foreign enrichment
 capabilities in the future, the timing and
 application of plutonium recycle technology,
 the role of the High Temperature Gas-Cooled
 Reactor (HTGR), and the introduction of the
 liquid metal-cooled fast-breeder reactor
 (LMFBR). The nuclear generating capacities
 in this forecast have been translated into
 demands for enrichment plant feed material,
 separative work, and other quantities based
 on the known and expected characteristics of
 nuclear reactors. Three forecasts have been
 prepared both for the United States and for
 other non-Communist countries; a most likely,
 a high, and a low case. The forecasts are
 based on an evaluation of announced, or
 known, plants in the United States and in
 other countries and on extrapolations of
 trends in energy consumption and electricity
 generating capacity. (Auth, from Summary)
 AVAILABILITY: GPO (\$3.70)

McTague, P. J., Davidson, G. J., "The
 Bredin, R. M., and Herman, A. A., "The
 Evolution of Nuclear Plant Costs",
 Nuclear News, v. 15-2, pp 31-35,
 February, 1972.

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1972
IEEE International Conference on Engineering in the Ocean Environment, Newport, R. I., 1972.
Ocean '72; record. [New York, Institute of Electrical and Electronics Engineers, 1972]
viii, 613 p. illus. 28 cm.
Held Sept. 13-15, 1972 in Newport, R. I.
"IEEE publication 72 OH 660-1 OCC."

1. Ocean engineering--Congresses. 2. Oceanography--Congresses. I. Institute of Electrical and Electronics Engineers. II. Title.

OFFSHORE NUCLEAR GENERATING STATIONS 407

Incentives to Offshore Siting of Generating Stations, Frederick W. Schneider and Herbert D. Reppin, Jr., *Public Service Electric and Gas Company* 408

Site Considerations Associated with Offshore Generating Stations, Muzaffer Kehnemuyi and Bert A. Johansen, *Public Service Electric and Gas Company* 412

Plant Considerations for Offshore Generating Stations, R. C. Nichols, *Offshore Power Systems, and J. A. Ashworth, Public Service Electric and Gas Company* 418

Environmental Considerations of Offshore Generating Stations, James R. Roney, *Public Service Electric and Gas Company* 419

1972

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IEEE Power Engineering Society Conference on Research for the Electric Power Industry, Washington, D.C., 1972.
Conference on research for the electric power industry. [New York, Institute of Electrical and Electronics Engineers, 1973]
455 p. illus. 28 cm.

THIRD SESSION - ENERGY CONVERSION I - NUCLEAR.
p.105-154.

R.C. Nichols.
Floating offshore power generating stations. J.A. Ashworth, *Trans. Am. Nucl. Soc. (USA)*, vol. 15, no. 2, p. 29 (Aug. 1972). (Conference on Nuclear Power for Tomorrow Summaries only, Atlantic City, N.J. USA, 22-25 Aug. 1972).

The off-shore nuclear generating station comprises an integrated nuclear power plant package of central-station size mounted on a single floating platform structure. The plant will remain afloat, moored inside a protective breakwater system some distance off shore. Underwater cables will transmit power to the shore. The power plant is a conventional Westinghouse pressurized-water reactor and turbine-generator system with an output of 1150 MW(e) designed for ocean water cooling with the conventional auxiliary systems and features. The Westinghouse ice condenser system is used for the containment system. The containment concept is similar to the TVA Sequoyah design. The reference plant design is based on the 3425-MW(th)-class four-loop plant widely under construction in the US. The plant layout and arrangement are quite conventional and similar to many single-unit land-based nuclear plants.

Power plants

1972

TUNED FLOATING PLATFORM FOR OFFSHORE POWER FACILITIES.
Mechanical Engineering, Oct. 1972, p. 37-42.

J.F. Holmes and C. R. Fink, Saunders Nuclear Corp.

Offshore siting offers such distinct advantages as thermal enhancement of the waters to increase recreational and commercial values, and a very important consideration along the west coast, earthquake-isolation of the bulk power reactor. Offshore siting brings with it new design considerations.

ATOMIC POWER: FALLACIES AND FACTS.
IEEE TRANS. Aerospace & Electronic Systems, v. AES-8, no. 5, Sept. 1972, p. 576-582.

TK
2896
1 55
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Intersociety Energy Conversion Engineering
Conference, 7th, San Diego, Calif., 1972.
Proceedings. Washington, D. C., American
Chemical Society, 1972.
1533 p. illus. 28 cm.

Combined Nuclear Gas Turbine Power and Desalination Plant, P. H. Sager, J. M. Krase . . . 1299
Exploratory Investigation of an Electric Power Plant Utilizing a Gaseous Core Reactor
with MHD Conversion, J. R. Williams, Y. Y. Yung, K. D. Kirby, J. D. Clement . . . 1305

FISSION: THE PRO'S AND CON'S OF NUCLEAR POWER.
Science, v.178, Oct.13,1972, p.147-149
By Allen Hammond.

NUCLEAR ENERGY AND ITS PROSPECTS IN INDIA.
Srinivasan, M. R. (Madras Atomic Power Project, Kalpakkam, India). pp 1-4 of Proceedings of the Seminar on Energy System Economics. New Delhi: National Productivity Council (1973).
From proceedings of the seminar on energy system economics; Madras, India (21 Aug 1972).

The prospects of nuclear energy in India are discussed taking into consideration: i) availability of coal (mostly) mainly in the Eastern region of India, ii) dependence of hydroelectric energy on the monsoons, iii) increasing per capita consumption rate of electric power, and iv) already existing basic infra-structure in terms of manpower and knowhow in the field of nuclear technology. It is pointed out that the situation favors the execution of a nuclear power program. Dr. Bhabha's three stage strategy for nuclear power development of India is explained. In the first stage, a number of nuclear power stations using natural uranium based nuclear fuels will be constructed. In the second stage, fast breeder reactors, using plutonium or thorium will be constructed, along with either depleted uranium or thorium will be constructed, Plutonium or uranium 233 produced in this stage and thorium will be utilized as fuel in the reactors of third-stage nuclear power stations. Tarapur Atomic Power Station, built on a turn-key

IS NUCLEAR FISSION ACCEPTABLE?

J.W. Gofman.
Futures, v.4, no.3, Sept.1972, p.211-219.

Nuclear fission appears to have been chosen as the major future energy resource. Many would hold that promotional opportunism of the nuclear establishment rather than merit has served as the basis for this choice.

Summary of Recent Legislative & Regulatory Activities
Affecting the Environmental Quality of Nuclear Facilities
—Compiles recent legislative and regulatory activities concerning environmental quality which have a possible bearing on the development and use of nuclear energy. Covers proposed and adopted Federal and state legislation. 1972.
175 pp. PC \$10/MF \$10 order ORNL-NSIC-93/G

ENVIRONMENTAL ASPECTS OF NUCLEAR ENERGY.

Landis, J. W. (American Nuclear Society, Hinsdale, IL). At. Jap.; 16: No. 4, Suppl., 5-56(Apr 1972). (CONF-720341-1).
From 5th Annual Conference of the Japan Atomic Industrial Forum; Tokyo, Japan (22 Mar 1972).

Atmospheric pollution is the most apparent and the most harmful effect of combustion of fossil fuel. Current free world demand for oil is about 40 million barrels a day. This means that there is only a 34 to 100 year supply, assuming no increase in the demand. Similar pictures for the availability of coal and natural gas exist. The most obvious environmental advantage of nuclear energy is total absence of combustion products and therefore atmospheric contamination. Another advantage of the nuclear energy is reduced capacity required for transportation and storage facilities. A third advantage of nuclear energy is vast amounts of fuel reserves in the crust of the Earth. But nuclear energy systems have certain disadvantages such as the discharge of waste heat, routine emission of radioactive material, unusual safety problems, and disposal of high-level radioactive wastes. And when high-temperature gas-cooled reactors are developed and operated, their waste heat and radioactive effluent will be smaller than that of light water reactors. Nuclear fusion reactors are promising because they discharge no radioactive wastes. (Japan)

74V11394 1972 ISS OC TD195.E4N48 1972 621.481 LC-73-622048
 ENVIRONMENTAL ASPECTS OF THE PROPOSED CFFSHORE NUCLEAR POWER PLANT;
 REPORT (PURSUANT TO ASSEMBLY RESOLUTION NO. 20, 1972)
 NEW JERSEY. LEGISLATURE. GENERAL ASSEMBLY. COMMITTEE ON AIR AND
 WATER POLLUTION AND PUBLIC HEALTH.
 TRENTON 16 P. MAP. 28 CM.
 COVER TITLE.

LC ATOMIC POWER-PLANTS -- ENVIRONMENTAL ASPECTS -- NEW JERSEY.
 ADDED N*US*NJ
 MAIN-CORP TRACE-TITL* CATALOG BY-LC

CN-129,035

1972
 THE ENVIRONMENTAL AND ECOLOGICAL FORUM 1970-1971.
 (Sponsored by: Health Physics Society, AAS, AAPM
 and Montgomery County Public School Adult Education
 Program). (Series title: Environmental and Ecological
 Forum Series). 1972. 186p.

Atomic Energy Commission
 Health Physics Society
 American Nuclear Society
 American Association of Physicists
 in Medicine

TID-25857

Conferences - Environment
 Environment
 Ecology
 Pollution
 Power sources, Nuclear
 Reactors, Nuclear - Safety
 L-10-20-72

CN-129,034

1972
 ECOLOGICAL ASPECTS OF THE NUCLEAR AGE: SELECTED
 READINGS IN RADIATION ECOLOGY. Vincent Schultz,
 Washington State U. and F. Ward Whicker, Colorado
 State U. 1972. 588p.

Atomic Energy Commission
 Washington State U.
 Colorado State U.
 Contract AT(11-1)-1156
 Contract AT(45-1)-2221

TID-25978

Human engineering & physiology - Radiation
 Ecology
 Radiation, Nuclear
 Power sources, Nuclear
 Radioactivity
 Environment
 L-10-20-72

Compilation of Nuclear Standards, 8th Edition, 1971—
 Part I: United States Activities—Presents all U.S. nuclear
 standards activities in simple tabular form. The pertinent
 technical, industrial, and environmental organizations are
 listed alphabetically and the standards activities are given
 for each. In addition to approved standards, unapproved
 drafts and proposed activities are also listed where the in-
 formation is available. 1972. 208 pp. PC \$12/MF \$12
 order ORNL-NSIC-98/G

Part II: National (excluding U.S.) and International Activi-
 ties—Presents all national and international nuclear stand-
 ards activities except for the U.S. work covered in Part I.
 The standards activities of all national organizations and
 technical societies, as well as relevant regulations estab-
 lished by government agencies are listed in alphabetical
 order by country or by international agency. 1972 140 pp.
 PC \$10/MF \$10 order ORNL-NSIC-102/G

1972

8

NUCLEAR POWER AND THE ENVIRONMENT.

Grendon, A. Forum (Chicago); 8: No. 1, 70-92 (Fall 1972).
The source of power for the next several decades must be between fossil fuel and nuclear fission. The discussion involves how nuclear power compares with the alternatives with respect to environmental effects. Nuclear fission provides a new source of energy to supplement the older resources, fossil fuels and water power. Nuclear fission power is being applied as heat to make steam to run turbines and generate electricity; to use the heat for distillation of salty or brackish water in order to augment the diminishing water supply; and to use steam from nuclear reactors in industrial processes and domestic heating. Objectionable waste heat could be used to prevent the undesired freezing of lakes and to enhance the productivity of farmlands by warm water irrigation. The undesirable effects involve the routine discharge of radioactive materials into the air and water, possible accidents during transport of nuclear materials, and safety hazards at the plants. Alternatives discussed include expanded use of fossil fuel plants and hydroelectric plants; and development and use of solar energy, geothermal energy sources, tidal power, wind, and fusion nuclear power. The possibility of reduced electricity use and an increase in the efficiency of electric generation by the use of MHD are suggested. (MCW)

Abnormal Reactor Operating Experience 1969-1971—
Contains 82 abnormal reactor operating experience reports published by the USAEC during the period January 1969 through December 1971. Arranges reports in chronological order with an index using keywords from the NSIC thesaurus of indexing terms. And, a permuted title index assists you in locating reports of interest. 1972. 201 pp.
PC \$8/MF \$8 order ORNL-NSIC-103/G

Survey of Nuclear Power Supply Prospects. Hittman Associates, Inc., Columbia, Md., Feb. 1972, 99p. \$4.85
PB-209 283

TK
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.G57

Gofman, John William
Poisoned power; the case against nuclear power plants, by John W. Gofman and Arthur R. Tamplin. With a foreword by Mike Gravel. Emmaus, Pa., Rodale Press, 1971.
368 p. illus. 23 cm.

- In one year's operation, a single nuclear power plant generates as much radioactive poison as one-thousand Hiroshima-type atomic bombs!
- Insurance companies — experts on judging risks — protect themselves against anticipated claims from private citizens for nuclear plant accidents and radioactive damage by specifically excluding such coverage in contracts.
- The AEC — designated as the public's "protector" — is charged with promoting the nuclear industry. This is an impossible conflict of interest.
- There is "not a shred of evidence" that AEC radiation standards for peaceful use of the atom are truly safe.
- Nuclear power is *not* the sole adequate source of electricity for the future. There are efficient alternatives — cleaner, cheaper, safer ones.

National Academy of Sciences
Proceedings, v.68, no.8, p.1919-1943 1971
Aug.

SYMPOSIUM ON ENERGY FOR THE FUTURE—PROBLEMS AND PROSPECTS. (Presented at the annual meeting of the NAS, Apr.1971).

National Academy of Sciences
Symposium on Energy for the Future -
Problems and Prospects
Apr. 1971

- Energy for the future—problems and prospects
- Introductory remarks
- Initiatives for the future of energy
- Electric power from nuclear fission
- Fusion power
- Power generation and the environment

NUCLEAR POWER: RISKS AND SOCIAL CONCERNS. p.19
 NUCLEAR POWER: SOCIAL NEEDS AND BENEFITS. p.29
 GLOBAL TEMPERATURE EFFECTS OF THE USE OF FUSION
 ENERGY AND THE FUSION TORCH. p.31
 A TECHNOLOGISTS RESPONSE TO PREDICTIONS OF CATASTROPHE. p.37

IEEE Trans. Nuc. Sci., v.NS-18, no.1, Feb.1971.
 (17th Nuclear Science Sym. and 2nd Nuclear Power
 Systems Sym., N.Y., N.Y., Nov.4-6,1970)

N71-24578* # National Aeronautics and Space Administration.
 Lewis Research Center, Cleveland, Ohio.

THE POTENTIAL OF NUCLEAR MHD ELECTRIC POWER
 SYSTEMS

G. R. Seikel and L. D. Nichols 1971 12 p refs Proposed for
 presentation at AIAA 7th Propulsion Joint Specialist Conf., Salt
 Lake City, 14-18 Jun. 1971
 (NASA-TM-X-67829; E-6304) Avail: NTIS CSCL 18L

The performance of the turbo-MHD cycle is compared with
 the equivalent Brayton-MHD and Brayton-turboelectric cycles. For
 the MHD cycles, a top temperature of 2500 K is assumed and
 two working fluids are considered. For the cycles with turbines,
 two turbine inlet temperatures are considered: 1500 and 1250K.
 The cycle temperatures, efficiencies, and specific radiator areas are
 compared for these various space power systems. The efficiency
 of the turbo-MHD system is also presented for ground power-
 plants. The specific masses of man shielded 10 MW electric space
 power systems are estimated. A brief discussion is then presented
 of the technology of the two most critical components of such an
 MHD systems. Included in this discussion is a possible modification
 of the turbo-MHD cycle to minimize the problems associated with
 alkali-metal-seeded generators and reactor fission product release.
 Author

WHITHER NUCLEAR POWER.

E.S. Booth.

Institution Electrical Engineers, v.118, no.9,
 Sept.1971, p.1215-1226.

ELECTRIC POWER FROM NUCLEAR FISSION.

M. Benedict.

Tech. Rev., v.74, no.1, Oct./Nov.1971, p.32-41.

(PB-207300) NUCLEAR ENERGY FOR A NEW TOWN.
 Hammerschlag, D.; Rose, V. C. (Rhode Island Univ., Kingston
 USA)). Aug 1971. 76p. Dep. NTIS \$6.00.

This document is concerned with methods of utilizing the waste
 heat from a proposed nuclear generating facility in an industrial -
 municipal complex. Several products and processes are proposed,
 including marine pharmaceuticals, chemical production, municipal
 waste processes, food production and processing, and residential -
 recreational uses. Sewage treatment was selected as the most
 promising use of the heat. This nonseasonal process can provide
 a solution to two regional problems: augmentation of municipal
 water supplies and elimination of a major source of water pol-
 lution. In the proposed system, sewage from the metropolitan
 Providence, R. I., area would be piped to the vicinity of the power
 plant, receive primary, secondary, and tertiary treatment to con-
 vert it to potable water and be piped back to the city's reservoir
 system. Heat from the power plant would be used in each stage to
 accelerate the process. Cost of the entire system was estimated
 at 74.3 million dollars. (auth)

TK
 1078
 .N82

Nuclear power; edited by R. V. Moore.
 Cambridge [Eng.] University Press in
 association with the Institution of
 Electrical Engineers, 1971.
 vii, 200 p. illus. 22 cm. (I. E. E.
 monograph series, 6)

1. Atomic power-plants. I. Moore,
 Richard Valentine, 1916- ed. II.
 Series: Institution of Electrical Engi-
 neers, London. I. E. E. monograph series, 6

A72-14376* # What can nuclear energy do for society. F. E.
 Rom (NASA, Lewis Research Center, Cleveland, Ohio). *American
 Institute of Aeronautics and Astronautics, Symposium on Uranium
 Plasmas: Research and Applications, 2nd, Atlanta, Ga., Nov. 15-17,
 1971, Paper. 24 p. 12 refs.*

Nuclear fuel is a compact and abundant source of energy. Its
 cost per unit of energy is less than that of fossil fuel. Disadvantages
 of nuclear fuel are connected with the high cost of capital equipment
 required for releasing nuclear energy and the heavy weight of the
 necessary shielding. In the case of commercial electric power
 production and marine propulsion the advantages have outweighed
 the disadvantages. It is pointed out that nuclear commercial
 submarines have certain advantages compared to surface ships.
 Nuclear powerplants might make air-cushion vehicles for trans-
 oceanic ranges feasible. The problems and advantages of a nuclear
 aircraft are discussed together with nuclear propulsion for inter-
 planetary space voyages.
 G.R.

73V28742 1971 ISS 00 JK1078.S92 197C LC-72-593451
 ECONOMIC INTEGRATION OF NUCLEAR POWER STATIONS IN ELECTRIC POWER
 SYSTEMS. PROCEEDINGS OF THE SYMPOSIUM ... JOINTLY ORGANIZED BY THE
 INTERNATIONAL ATOMIC ENERGY AGENCY AND THE ECNCMC COMMISSION FOR
 EUROPE OF THE UNITED NATIONS AND HELD IN VIENNA, 5-5 OCT. 1970.
 SYMPOSIUM ON ECONOMIC INTEGRATION OF NUCLEAR POWER STATIONS IN
 ELECTRIC POWER SYSTEMS, VIENNA, 1970.
 INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, 738 F. ILLUS., DIAGRS.,
 TABLES. 24 CM.
 \$20.00 (U.S.) IN ENGLISH, FRENCH, RUSSIAN, SPANISH PROCEEDINGS SERIES
 "STI/PUB/266." IN ENGLISH, FRENCH, RUSSIAN, OR SPANISH; ABSTRACTS IN
 ENGLISH. INCLUDES BIBLIOGRAPHICAL REFERENCES.
 LC ATOMIC POWER-PLANTS -- CONGRESSES.
 ADDED INTERNATIONAL ATOMIC ENERGY AGENCY. UNITED NATIONS. ECNCMC
 COMMISSION FOR EUROPE. INTERNATIONAL ATOMIC ENERGY AGENCY. PROCEEDINGS
 SERIES

74V29372 1971 ISS 00 JX1974.7.C579 1970 327.17 LC-77-150710
 CIVIL NUCLEAR POWER AND INTERNATIONAL SECURITY. EDITED BY MASCN
 WILLRICH.
 CONFERENCE ON CIVIL NUCLEAR POWER AND INTERNATIONAL SECURITY.
 UNIVERSITY OF VIRGINIA, 1970.
 PRAEGER NEW YORK. XVI, 124 P. 25 CM.
 PRAEGER SPECIAL STUDIES IN INTERNATIONAL POLITICS AND PUBLIC AFFAIRS
 SPONSORED BY THE CENTER FOR THE STUDY OF SCIENCE, TECHNOLOGY AND PUBLIC
 POLICY, UNIVERSITY OF VIRGINIA.
 LC ATOMIC POWER -- INTERNATIONAL CONTROL. ATOMIC WEAPONS AND
 DISARMAMENT.
 ADDED WILLRICH, MASCN, ED. VIRGINIA. UNIVERSITY. CENTER FOR THE
 STUDY OF SCIENCE, TECHNOLOGY AND PUBLIC POLICY.
 MAIN-MEET TRACE-CORP*IIIL*AUTH* CATLG BY-LC

74V36950 1971 ISS 00 ID427.H4U52 621.481 LC-78-614740 SOD Y
 3.A17 22/WASH-1169/2
 THERMAL EFFECTS AND U.S. NUCLEAR POWER STATIONS.
 UNITED STATES. ATOMIC ENERGY COMMISSION. DIVISION OF REACTOR
 DEVELOPMENT AND TECHNOLOGY.
 FOR SALE BY THE SUPT. OF DOCS., U.S. GOVT. PRINT. OFF., WASHINGTON;
 V. 40 P. ILLUS. 27 CM.
 \$0.50 "WASH-1169." INCLUDES BIBLIOGRAPHICAL REFERENCES.
 LC THERMAL POLLUTION OF RIVERS, LAKES, ETC. -- UNITED STATES. ATOMIC
 POWER-PLANTS -- UNITED STATES.
 ADDED N*US***

73V30881 1971 ISS OC TK1078.G42 621.481 LC-72-614334 SOC EP
 2.10 16130GFI06/71
 POTENTIAL ENVIRONMENTAL EFFECTS OF AN OFFSHORE SUBMERGED NUCLEAR
 POWER PLANT.
 GENERAL DYNAMICS CORPORATION. ELECTRIC BOAT DIVISION.
 ENVIRONMENTAL PROTECTION AGENCY. WATER QUALITY OFFICE : FOR SALE BY
 THE SUPT. OF COCS., U.S. GCVT. PRINT. OFF., WASHINGTON 2 V. ILLUS. 28
 CM.
 WATER POLLUTION CONTROL RESEARCH SERIES \$2.50 (V. 1) \$2.25 (V. 2)
 "16130 GFI 06/71." PREPARED UNDER CONTRACT NO. 14-12-918. INCLUDES
 BIBLIOGRAPHICAL REFERENCES.
 LC MARINE ECOLOGY. RADIOACTIVE POLLUTION OF THE SEA. ATOMIC
 POWER-PLANTS.
 ADDED UNITED STATES. ENVIRONMENTAL PROTECTION AGENCY. WATER QUALITY
 OFFICE.
 MAIN-CORP TRACE-SERS*CCRP*ITIL* CATLG BY-LC

72V30492 1971 ISS OC TK9023.6.G46 621.480578 LC-70-30780
 NUCLEAR ENERGY IN THE WEST: CURRENT AND PROJECTED NUCLEAR ACTIVITIES
 IN THE MEMBER WESTERN STATES.
 GEORGE D. WARD & ASSOCIATES. NUCLEAR DIVISION.
 WESTERN INTERSTATE NUCLEAR BOARD, LAKEWOOD, COLC. XIII, 109 P.
 ILLUS. 28 CM.
 \$5.00
 LC ATOMIC POWER INDUSTRY -- THE WEST. ELECTRIFICATION -- THE WEST.
 ADDED N*USP** WESTERN INTERSTATE NUCLEAR BOARD.
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74V24497 1971 ISS OC TK9145.W49.621.48 LC-76-158105
 A/WILLRICH, MASON.
 GLOBAL POLITICS OF NUCLEAR ENERGY.
 PRAEGER PUBLISHERS NEW YORK, XII, 204 P. ILLUS. 25 CM.
 PRAEGER SPECIAL STUDIES IN INTERNATIONAL POLITICS AND PUBLIC AFFAIRS
 INCLUDES BIBLIOGRAPHICAL REFERENCES.
 LC NUCLEAR ENGINEERING. ATOMIC ENERGY RESEARCH -- INTERNATIONAL
 COOPERATION.
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72V32875 1971 ISS 00 TK1344.N7N4 C-8C14C6-34-X 328.476213121309747
LC-70-147316

A/NELKIN, DOROTHY.

NUCLEAR POWER AND ITS CRITICS: THE CAYUGA LAKE CONTROVERSY.
CORNELL UNIVERSITY PRESS ITHACA, X, 128 P. ILLUS., MAP. 21 CM.
SCIENCE, TECHNOLOGY, AND SOCIETY \$6.50 INCLUDES BIBLIOGRAPHICAL
REFERENCES.

LC ATOMIC POWER-PLANTS -- NEW YORK (STATE)

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MAIN-AUTH TRACE-SERS*TITL* CATALOG BY-LC

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73V21151 1970 ISS 00 TK9006.S8 621.48309752 LC-72-176357

NUCLEAR POWER PLANTS AND OUR ENVIRONMENT: A REPORT TO THE MARYLAND
ACADEMY OF SCIENCES BY THE STUDY PANEL ON NUCLEAR POWER PLANTS.
STUDY PANEL ON NUCLEAR POWER PLANTS.

BALTIMORE II, 49 L. 28 CM.

BIBLIOGRAPHY LEAVES 48-45.

LC ATOMIC POWER-PLANTS -- MARYLAND -- CONGRESSES. POLLUTION --
MARYLAND -- CONGRESSES.

ADDED N*US*MD

MAIN-CORP TRACE-TITL* CATALOG BY-LC

74V34144 1970 ISS 00 TK1078.M83 C-816605-81-5 621.483 LC-78-139961
NUCLEAR POWER AND THE PUBLIC. HARRY FOREMAN, EDITOR.

UNIVERSITY OF MINNESOTA PRESS MINNEAPOLIS, XVIII, 273 P. ILLUS. 25
CM.

\$9.00 BASED UPON A SYMPOSIUM HELD AT THE UNIVERSITY OF MINNESOTA,
OCT. 10-11, 1969. INCLUDES BIBLIOGRAPHIES.

LC ATOMIC POWER-PLANTS -- ENVIRONMENTAL ASPECTS -- CONGRESSES.
RADIOACTIVITY -- PHYSIOLOGICAL EFFECT -- CONGRESSES.

ADDED FOREMAN, HARRY, 1915- ED. MINNESOTA UNIVERSITY.

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Symposium on Environmental Aspects of Nuclear
Power Stations, New York, 1970.
Environmental aspects of nuclear power
stations. Proceedings of a symposium...held
by the International Atomic Energy Agency in
co-operation with the United States Atomic
Energy Commission in New York, 10-14 Aug. 1970.
Vienna, International Atomic Energy Agency,
1971.
970 p. illus. 24 cm.
"STI/PUB/261."

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Environmental surveillance in the vicinity of nuclear facili-
ties. Proceedings of a symposium. Edited by William C.
Reinig, Springfield, Ill., C. C. Thomas, 1970,
xvi, 465 p. illus. 27 cm.
Includes bibliographical references.

CM-126,989

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NUCLEAR POWER IN THE SOUTH. (A Report of the
Southern Governors' Task Force for Nuclear Power
Policy. Presented at the 1970 Southern Governors'
Conference, held on Sept. 22, 1970). 138p.

Southern Governors' Task Force for
Nuclear Power Policy
(Southern Interstate Nuclear Board)
Southern Governors' Conference Sept. 22,
1970
.23

Power sources, Nuclear
Reactors, Nuclear
Reactors, Nuclear - Safety

Pollution
Public policy--

N70-37284# United Kingdom Atomic Energy Authority, Risley
(England) Reactor Group.
HIGH-TEMPERATURE REACTOR
N. H. McLaren Apr. 1970 15 p refs
(TRG-Rept-1996) Avail: AEC Depository Libraries
In the U. K. the helium cooled high temperature reactor
is known as the Mark III GCR, Mark I and II being the Magnox
and AGR designs, respectively. The development of the reactor
engineering and of the fuel is described. A description of a typical
Mark III reactor design is given. NSA

N70-18219# Atomic Energy Commission, Washington, D. C.
Div. of Reactor Development and Technology.
USE OF THORIUM IN NUCLEAR POWER REACTORS
Jun. 1969 144 p refs
(WASH-1097) Avail: SOD \$1.25

A review of the potential use of Th in power reactors is
presented. Different reactor types are analyzed for Th fuel cycles.
Characteristics of Th fuel cycles are described. Cost factors and
long-range fuel demands and requirements are analyzed for power
reactors. Design parameters for a conceptual 1000 MW(e) molten
salt breeder reactor are presented. NSA

N68-18384# Atomic Energy Commission, Washington, D. C.
Div. of Industrial Participation.
THE NUCLEAR INDUSTRY
1967 184 p Presented at the Atomic Indus. Forum's Ann. Conf.,
Chicago, 6 Nov. 1967
(TID-24102; CONF-671115-1) GPO: \$1.00

The peaceful application of nuclear energy that has the
most impact on the U.S. economy is that of nuclear reactors to
produce steam for generation of electric power. The volume of
orders for nuclear-electric generating units for 1966 is compared
with that for nine months of 1967. Other applications of nuclear
energy are associated with desalting water, providing electric
power for space and the ocean bottom, commercial explosives,
preserving food, and producing new wood-plastic products. NSA

BREEDER REACTORS: Bibliography
compiled by the U.S. Atomic Energy
Commission of recent publications on
liquid sodium fast breeder reactors.
328 pages. (Report TID-3333-S1, available
through AEC/contractor channels or
at \$10.60 from NTIS, U.S. Dept. Commerce,
Springfield, Va. 22151.

THE FAST-BREEDER REACTOR: WHEN, WHERE, WHY, AND HOW?
G.D. Friedlander.
IEEE Spectrum, v.11, no.2, Feb.1974, p.85-89.

An LMFBER plant will be built and the HTGR is under
study; the factors involved are efficiency and safety.

THE FAST-BREEDER REACTOR: ENERGY SOURCE OF THE
FUTURE.

R. Balent and R.J. Beeley.
Energy Sources, v.1, no.2, 1974.

BREEDER REACTOR DEBATE: THE SUN ALSO RISES.
R. Gillette.
Science, v.184, no.4137, May 10, 1974, p.505
p.650-51.

In effect the AEC may be involved in another
Washington cover-up-----this time an attempt to
cover up the sun. Barry Commoner said, the AEC
apparently has suppressed an optimistic report
on the potential usefulness of solar energy that
undermined the AEC's case for the breeder program.

BREEDER REACTORS A FAUSTIAN DILEMMA: UNLIMITED
POWER OR UNPARALLELED RISKS?
J. H. Weinberg.
Science News, v.106, no.1, July 6, 1974, p.12,13,15.

Article discusses how the breeder works and
specific objections to the breeder reactor.

Fast breeder reactor. Energy source for the future.
Balent, R.; Beeley, R. J. (At. Int. Div., Rockwell Int. Corp.,
Thousand Oaks, Calif.). *Energy Sources* 1974, 1(2), 189-200
(Eng). A review with 6 refs.

TITLE: Fission Energy and Other Sources of Energy
AUTHOR: Alfven, H.
PUBLICATION DESCRIPTION: Bulletin of the Atomic Scientists, Science and Public Affairs, 30(1), 4-8

PUBLICATION DATE: 1974, January
ABSTRACT: In order to produce more energy, the development of fission reactor technology is proceeding worldwide at a rapid pace. Part of the reason for this emphasis may be associated military support, either direct or indirect. The possible dangers of the large scale use of breeder reactors, with the huge production of plutonium, are pointed out. Intensive research efforts should be made to develop other sources of energy, such as fusion, geothermal, and solar. (JMC)

NUCLEAR BREEDERS.

S. Novick.

Environment, v.16, no.6, July/Aug.1974, p6-15.

Nuclear power plants of a new design to produce power and fuel are proposed by the Atomic Energy Commission, in a crash program which overstates benefits, ignores hazards, and fails to take into account alternatives including the programs of other federal agencies.

LMFBR CRITIQUE: A study sponsored by Resources For the Future, Inc., challenging massive U.S. government fiscal and technical personnel commitments. (The Liquid Metal Fast Breeder Reactor: An Environmental and Economic Critique, available at \$6.50 from the Johns Hopkins University Press, Baltimore, Md. 21218.)

1973

(WASH-1103(2nd Ed.)) LMFBR: LIQUID METAL FAST BREEDER REACTOR PROGRAM PLAN. Element 3. Plant Systems and Components. (Argonne National Lab., Ill. (USA)). Dec 1973. 392p. Dep. NTIS \$10.60.

The objective of the work outlined in the Plant Systems and Components Element of the LMFBR Program Plan is to provide for the first-of-a-kind development of those systems and components necessary for successful commercial LMFBR heat-transport system; auxiliary reactor plant system; component cleaning, inspection, and maintenance facilities; shielding, containment, and reactor service buildings; and energy conversion and power generation. The near-term focus is on the development efforts needed for the timely completion of the demonstration-plant program so that the accrued technology along with that obtained from FFTF and other ongoing programs provide a firm basis on which to proceed to commercially viable plants and a true breeder economy. Specific systems included in this Element are the primary and secondary coolant systems (pumps, IHX, valves, and fittings); steam generation system (steam generator, feedwater system, etc.); auxiliary reactor plant systems (liquid-metal receiving and processing, inert-gas receiving and processing; impurity monitoring, sampling and analysis; auxiliary heating and cooling, and radioactive-waste processing; component cleaning, inspection, and maintenance facilities; shielding, containment, and reactor service buildings; and energy conversion and power generation system (generator and switch). (auth)

1973

WASH-1102(2nd Ed.) LMFBR: LIQUID METAL FAST BREEDER REACTOR PROGRAM PLAN. Element 2. Plant Design. (Argonne National Lab., Ill. (USA)). Dec 1973. 215p. Dep. NTIS \$7.60.

The Plant Design Element, which is concerned with the development of plant concepts and related plant-design technology, deals most directly with the objective of the program—the development of a technology for LMFBR power plants for the utility environment. The design process develops technical descriptions of plant concepts. This process requires that choices be made. Plant features and parameters are selected; functional requirements are established; technology status is evaluated, and research and development needs are identified. Design trade-off studies are a normal part of this effort—e.g., alternative design features with greater associated risks or increased development requirements versus more conservative features and related lower performance, and improved reliability versus increased costs. In every case, Plant Design is interested in the combination of choices that leads to the best overall plant. (auth)

WHY THE BREEDER PROGRAM IS UNDER ATTACK.
 Business Week, Nov.10,1973, p.222,223.

OVERALL STATUS OF LMFBF DEMONSTRATION PLANT. Copeland, R. L. (Project Management Corp., Chicago). Proc. Amer. Power Conf.; 35: 161-167(1973).

From The American Power conference; Chicago, Illinois, USA (8 May 1973). See CONF-730582.

The best long-term hope for easing the energy crunch is the nuclear power and, specifically, the liquid-metal-fast-breeder reactor. Tennessee Valley Authority and Commonwealth Edison accepted a proposal from the AEC to construct the demonstration plant near Oak Ridge, Tennessee. The Breeder Reactor Corporation and Project Management Corporation were incorporated in March 1972 as a result of the efforts of TVA and CECO. The plant will be designed for a 30-year life, with an electrical rating of about 400 megawatts. The temperature of the sodium leaving the reactor will be about 1000°F. There will be three heat transport loops and the primary sodium pump will be located in the hot leg between the reactor vessel outlet and the IHX. Argon will be the cover gas for the primary and secondary systems. Technology exists for the design of a safe, operable, and reliable plant and remains to be applied to the engineering and fabrication of large-scale high-quality LMFBF components. The funding of the project is briefly described. (MCW)

STATUS AND SAFETY ASPECTS OF THE 300-MWe GCFR DEMONSTRATION PLANT. Milord, S. J. (American Electric Power Service Corp., New York); Larrimore, J. A. Proc. Amer. Power Conf.; 35: 198-206(1973).

From The American Power conference; Chicago, Illinois, USA (8 May 1973). See CONF-730582.

The status of the design and development of the 300-MW(e) Gas-Cooled Fast Breeder Reactor and its safety aspects are presented. The GCFR offers a most attractive and viable alternative to the LMFBF. Operability and maintainability appear promising. The principal safety costs and schedules for a construction project have been completed. GCFR licensing requirements can be based on RTOR and LWR precedents. (MCW)

S-444

HOW THEY'RE SOLVING OUR BREEDER REACTOR'S WEIRD PROBLEMS.

A.P. Armagnac.

Popular Science, Aug. 1973, p. 62-65, 113.

Designing tomorrow's atomic power plant looks like an engineering nightmare-but it's probably the answer to abundant electricity for you in coming decades.

THE ROLE OF HTGRs AND FBRs IN MEETING THE ENERGY CRISIS. P. Fortescue and H.B. Stewart.

Mech. Engineering, v. 95, no. 11, Nov. 1973, p. 14-17.

The fast breeder reactor uses a uranium cycle to refuel itself; however, its excess bred fuel can best be exploited in a high-temperature gas-cooled reactor, a thorium-cycle-based converter type. For this purpose, fissile feed material such as U-233 can be used to complement each other, a fortunate circumstance in the effort to successfully meet the long-range energy crisis.

TITLE: Nuclear Energy: How Soon? How Safe?

AUTHOR: Laro, R.G.

ADDRESS: Alexandria, VA

PUBLICATION DESCRIPTION: Consulting Engineer,

80(3), 144-163

PUBLICATION DATE: 1973, March

ABSTRACT: Nuclear reactors used for electric

power generation are described in some

detail, including boiling water reactors,

pressurized water reactors, high temperature

gas cooled reactors, and the liquid metal

fast breeder reactor. Also discussed are

reactor control and nuclear safety systems,

radioactivity build-up, spent fuel

reprocessing, and radiation hazards. In

spite of the risks, the U.S. seems to have no

choice other than nuclear power plants in the

short term. (1973)

BREEDER PROGRAM: BETHE PANEL CALLS FOR REORIENTATION. Science, v. 182, Dec. 21, 1973, p. 1236-37.

Exploratory study of a Satellite Nuclear Power Station (SNPS).

J.R. Williams, J.D. Clement (Georgia Inst. Technol., Atlanta, USA).

Trans. Am. Nucl. Soc. (USA), vol. 16, p. 242-3 (June 1973). (1973 Annual

Meeting of the American Nuclear Society (Summaries), Chicago, Ill., USA,

10-14 June 1973).

A new concept in nuclear power generation is proposed that will eliminate or

greatly reduce the problems currently associated with nuclear power plants.

This system is related to the Satellite Solar Power Station (SSPS) proposed by

Glaser (1972). The Satellite Nuclear Power Station (SNPS) would utilize the

same energy transmission system. A closed-cycle nuclear-MHD power plant

would generate electric power with an overall thermal efficiency in the range of

from 40 to 60%. Four breeder reactor types have been considered: a graphite

core, NERVA-type reactor, a molten core or rotating fluidized bed reactor, a

'light bulb' gas tube reactor and a coaxial-flow gas core reactor. (10 refs.)

A73-38412 * # The Satellite Nuclear Power Station - An

option for future power generation. J. R. Williams and J. D. Clement

(Georgia Institute of Technology, Atlanta, Ga.). In: Intersociety

Energy Conversion Engineering Conference, 8th, Philadelphia, Pa.,

August 13-16, 1973, Proceedings. (A73-38386 19-03) New York,

American Institute of Aeronautics and Astronautics, Inc., 1973, p.

566-573. 22 refs. Grant No. NGR-11-002-145.

A new concept in nuclear power generation is being explored

which essentially eliminates major objections to nuclear power. The

Satellite Nuclear Power Station, remotely operated in synchronous

orbit, would transmit power safely to the ground by a microwave

beam. Fuel reprocessing would take place in space and no radioactive

materials would ever be returned to earth. Even the worst possible

accident to such a plant should have negligible effect on the earth.

An exploratory study of a satellite nuclear power station to provide

10,000 MWe to the earth has shown that the system could weigh

about 20 million pounds and cost less than \$1000/KWe.

BREEDER REACTORS - DESIGN FOR SAFETY. *PART 1*

E. Gilby.

New Scientist, Feb.22,1973, p.418-421.

Breeder reactors can be the salvation of mankind or the ultimate folly. The breeder program in the US is already challenged by environmentalists who question its safety. In the first of three articles on social aspects, a nuclear engineer discusses the safety of breeder reactors.

BREEDERS: RISKS MAN DARE NOT RUN. J. Tinker. *PART 2*
New Scientist, v.57, no.835, p.473-, Mar.1,1973.

Breeder reactors will be inherently more dangerous to operate than conventional nuclear power plants. Their fuel cycles will place weapons-grade plutonium within the grasp of terrorists and their long-life radioactive wastes will require safe storage for half a million years.

NUCLEAR ESTABLISHMENT AT THE WATERSHED? *PART 3*

M, Kenward.
New Scientist, Mar.8,1973, p.539-541.

Final article in a series on the implication of fast breeder reactors.

TITLE: Electricity Investments Under Uncertainty: Waiting for the Breeder

AUTHOR: Hanne, A.S.
CORPORATE AUTHOR: Stanford University, Institute for Mathematical Studies in the Social Sciences

ADDRESS: Stanford, CA 94305
PUBLICATION DESCRIPTION: Working Paper No. 23, The Economic Series, Revised version of paper presented at SSP Conference on Energy: Demand, Conservation and Institutional Problems, MIT, February 12-14, 1973, 38 p.

PUBLICATION DATE: 1973, May
SPONSOR: National Science Foundation
ABSTRACT: This paper is concerned with the selection of an optimal mix of electric power plants to be installed during the 1980's. It focuses on the problem of uncertainty concerning the date breeder reactors will be commercially available. Sequential probabilistic linear programming is used. Assuming that the breeder reactor will become economical at some point during the 1990's, this approach makes it possible to optimize the mix of fossil, nuclear, and peeped storage plants installed in the 1980's. The calculations indicate that initial policies will be the same whether the breeder availability date is a random variable or a point estimate. (MPC)

(TID-26528, pp 169-219) ADVANCED NUCLEAR POWER. Chapter IV. Bethe, H. A. (Cornell Univ., Ithaca, NY). Dec 1973.

In report of the Cornell workshops on the major issues of a national energy research and development program, September 14, 1973-October 17, 1973.

The view is presented that the fast breeder and the fusion reactor are the only forms of technology now in sight that will give long-range, ample sources of energy. The feasibility of fusion has not been established. The LMFBR progress has been slow. High-grade uranium ore sources may become short in two to three decades if the ores continue to be needed in LWRs, etc. So with the technology of the breeder at hand, it is urgent that these be developed now. The most important characteristic of the breeder is the doubling time, the time it takes for the amount of fissile material to double. Technological, safety, and economic comparisons of the breeder and fusion reactors are made. Research on laser fusion and fusion by magnetic confinement are discussed with the laser fusion military applications indicated. Uranium ores; breeder calculations; the Doppler effect; Doppler effect and hypothetical accident; brief history of the breeder; history of laser-fusion; and future demand for uranium ore are subjects covered in the appendices. (MCV)

N74-11439# Atomic Energy Commission, Oak Ridge, Tenn. Technical Information Center.
NATIONAL TOPICAL MEETING ON NEW DEVELOPMENTS IN REACTOR PHYSICS AND SHIELDING, BOOK 1
 1972 586 p refs Meeting held at Kiamasha Lake, N. Y., 12-15 Sep. 1972.
 (Conf-720901-Bk-1) Avail: NTIS HC \$15.00 as set of two books

The papers presented at the conference on Reactor Physics are reported. Topics discussed include: reactor physics in the thermal range; reactor theory, and reactor shielding. For individual titles, see N74-11439 through N74-11479.

N74-11480# Atomic Energy Commission, Oak Ridge, Tenn. Technical Information Center.
NATIONAL TOPICAL MEETING ON NEW DEVELOPMENTS IN REACTOR PHYSICS AND SHIELDING, BOOK 2
 1972 617 p refs Meeting held at Kiamasha Lake, N. Y., 12-15 Sep. 1972.
 (Conf-720901-Bk-2) Avail: NTIS HC \$15.00 as set of 2 Books

Fast critical experiments and delayed neutron effect data are applied to obtain the physical parameters for design and development of fast breeder reactors. For individual titles, see N74-11481 through N74-11517.

TITLE: Nuclear Power 1973-2000
CORPORATE AUTHOR: U.S. Atomic Energy Commission, Office of Planning and Analysis, Forecasting Branch

PUBLICATION DESCRIPTION: Report No. WASH-1139

1972, 82 p.

PUBLICATION DATE: 1972, December 1
ABSTRACT: A new forecast of the growth of nuclear power in the United States and the rest of the world has been prepared for use in AEC production planning and for other purposes. This forecast includes a revision and updating of the information presented in the AEC's 1971 forecast, WASH-1135 (Rev. 1), and an extension of the forecast through the year 2000. It represents the current evaluation of domestic and foreign growth trends in nuclear power, foreign enrichment capabilities in the future, the timing and application of plutonium recycle technology, the role of the high temperature gas-cooled reactor (HTGR), and the introduction of the liquid metal-cooled fast-breeder reactor (LMFBR). The nuclear generating capacities in this forecast have been translated into demands for enrichment plant feed material, separative work, and other quantities based on the known and expected characteristics of nuclear reactors. Three forecasts have been prepared both for the United States and for other non-Communist countries: a most likely, a high, and a low case. The forecasts are based on an evaluation of announced, or known, plants in the United States and in other countries and on extrapolations of trends in energy consumption and electricity generating capacity. (Auth, from Summary)

AVAILABILITY: GPO (\$5.70)

1972

1972

GAS COOLED FAST BREEDER REACTOR DESIGNS.

PART 1 - THE 300-MW(e) GCFR DEMONSTRATION PLANT.
 J.B. Dee and G.B. Melese-d'Hospital, Gulf General Atomic.

Mech. Engineering, v.94, no.1, Jan.1972, p.18-22.

The authors discuss the 300-MW(e) plant with its indirect steam cycle and safety features.

GAS COOLED FAST BREEDER REACTOR DESIGNS. PART 2 - PERFORMANCE STUDIES OF LARGE GCFR PLANTS.
 J.B. Dee and G.B. Melese-d'Hospital, Gulf General Atomic.

Mech. Engineering, v.94, no.2, Feb.1972, p.28-31.

Performance of large GCFR designs is discussed and compared with published designs of 1000-MW(e) LMFBRs.

ENERGY FROM BREEDER REACTORS.

F.L. Culler, Jr. and W.O. Harms.

Physics Today, May 1972, p.28-39.

Reactors that consume relatively abundant uranium ores while generating more of and expensive "catalyst" than they use will be our answer to growing energy demands over the next fifty years.

1972

(WASH-1105(2nd Ed.)) LMFBR: LIQUID METAL
FAST BREEDER REACTOR PROGRAM PLAN. Element 5.
Sodium Technology. (Argonne National Lab., Ill. (USA)). Dec
1972. 478p. Dep. NTIS \$6.00.

The Sodium Technology Element is concerned with the develop-
ment of a base technology adequate to provide reasonable as-
surance of LMFBR plant reliability and life. Since the Element is
mission oriented, basic understanding is called for only where it
is needed to support design and operation of the LMFBR plants.
The most significant problem area is that of interactions of clad-
ding and structural materials with sodium and its impurities. Ac-
ceptable sodium-impurity limits must be defined and formulated
into appropriate system specifications and RDT Standards. In-
cluded in the sodium technology program are studies on the be-
havior and control of fission products in the coolant sodium and cov-
er-
on failed fuel monitoring (FFM) systems. For sodium and cover-
gas purification systems, on-line monitors and FFM systems,
this Element extends beyond base technology and concept develop-
ment and includes the design, fabrication, proof testing and pro-
curement of components. (auth)

1972

(WASH-1107(2nd Ed.)) LMFBR: LIQUID METAL
FAST BREEDER REACTOR PROGRAM PLAN. Element 7.
Fuels and Materials. (Argonne National Lab., Ill. (USA)). Dec
1972. 194p. Dep. NTIS \$3.00.

Areas of work covered in the Fuels and Materials Element to
develop technology for fuels, cladding, fuel elements, control ele-
ments, structural materials, and materials for other applications
extend from base technology through proof-of-principle. More
specifically, the Fuels and Materials Element outlines programs
designed to: (1) Determine in- and out-of-reactor properties of
materials, with emphasis on the effect of LMFBR conditions; (2)
Determine and understand the effect of pertinent variables on the
behavior of materials under possible LMFBR conditions; (3) De-
velop specific materials data as required for design, specifica-
tion, and procurement; (4) Implement performance tests of ma-
terials as required for components under expected LMFBR
conditions; (5) Establish performance limits of fuel-element ma-
terials under expected LMFBR conditions; (6) Determine the be-
havior of defective fuel elements; (7) Develop technology and
processes for fabrication of fuels and other components, as the
needs are identified, to the point of specific applications; (8) De-
velop and apply nondestructive testing and examination methods;
(9) Ensure the availability of adequate procedures for quality
assurance and standardization; (10) Stockpile well characterized
materials for experimental programs where appropriate. Within
each area, emphasis is placed on meeting the requirements that
arise because LMFBR conditions are beyond present practical
experience. (auth)

1972

(WASH-1108(2nd Ed.)) LMFBR: LIQUID METAL
FAST BREEDER REACTOR PROGRAM PLAN. Element 8.
Fuel Recycle. (Argonne National Lab., Ill. (USA)). Dec 1972.
232p. Dep. NTIS \$3.00.

The Fuel Recycle Element of the Program Plan outlines de-
velopments and schedules required for an orderly and efficient
demonstration of fuel-recycle technology adequate to facilitate
the growth of a viable LMFBR-power industry. The scope of the
program for the Fuel Recycle Element is that portion of the fuel
cycle between removal of partially spent fuel and blanket material
from the reactor site and return to the reactor site of newly
fabricated fuel and blanket assemblies. Operations in the fuel cy-
cle include shipping, reprocessing, preparation and fabrication,
fuel materials management, and management of wastes. Also in-
cluded in the Fuel Recycle Element are the general fuel-cycle
studies pertinent to all of the fuel-recycle operations, - e.g.,
studies of economics, siting criteria for reprocessing plants,
safety, fuel accountability, liability risks, safeguards, and gov-
ernment licensing and regulation. Two important responsibilities
of the Fuel Recycle programs are the demonstration of commercial
fabrication capabilities for initial cores, and the development and
demonstration of quality assurance technology to permit industry
to fabricate fuel which can meet LMFBR-design objectives. (auth)

1972

(WASH-1109(2nd Ed.)) LMFBR: LIQUID METAL
FAST BREEDER REACTOR PROGRAM PLAN. Element 9.
Physics. (Argonne National Lab., Ill. (USA)). Dec 1972. 414p.
Dep. NTIS \$6.00.

The Physics element of the Program includes all applied re-
search and development on differential and integral data and theo-
retical methods dealing with the interaction of neutrons and gamma
rays with all materials in the reactor system. All the applied R&D
required to generate nuclear data, and develop techniques and
understanding for the nuclear design of Demonstration, Test and
Commercial power plants and the establishment of an LMFBR in-
dustry are included. Direct design-support activities-- such as
mockup criticals and neutronic core design-- design, construction,
and fuel production are also included. Determination of the tech-
nical status of, and related confidence in, physics design methods
is an integral part of the program evaluation. Evaluation includes
surveys, intercomparisons, economic analyses, and correlations
between predictions and observations on actual systems. The quan-
titative correlations will include work to indicate the state of the
art at any time. This effort includes maintaining an awareness of
related work and coordination with related physics activities being
carried out under the sponsorship of other divisions of the AEC,
other federal agencies, and foreign R&D establishments. (auth)

1972-
(WASH-1106(2nd Ed.)) LMFBR: LIQUID METAL
FAST BREEDER REACTOR PROGRAM PLAN. Element 6.
Reactor Systems and Components. (Argonne National Lab., Ill.
(USA)). Dec 1972. 337p. Dep. NTIS \$6.00.

This Element of the LMFBR Program Plan describes develop-
ment work needed for the design of the Reactor Heat Generation
System and the Core Component Handling System of an LMFBR

power plant, in the near term for demonstration plants and in
longer range for safe and reliable target plants capable of com-
petitive operation in electric utility systems. The Reactor Heat
Generation System (RHGS) encompasses the reactor vessel and
all systems and components therein as required for delivering the
rated thermal output of the plant to the interfacing Heat Transport
System for breeding new fuel from fertile material, and for "burn-
ing" the reactor fuel efficiently. The Core Component Handling
System (CCHS) encompasses all systems and components re-
quired to transport fuel and related assemblies from the new fuel
receiving station to the reactor, and from the reactor to the spent
fuel shipping station, including preparation for exposure in the
reactor, storage after exposure and preparation for shipment.
(auth)

TITLE: International Conference on Nuclear

Solutions to World Energy Problems

CORPORATE AUTHOR: American Nuclear Society Inc.

ADDRESS: 248 East Ogden Ave., Hinsdale, IL 60521

PUBLICATION DESCRIPTION: Proceedings of the

Plenary Sessions held November 13-17, 1972.

Washington, DC. 358 p.

PUBLICATION DATE: 1972

SPONSOR: Atomic Industrial Forum: American

Nuclear Society

ABSTRACT: Twenty-nine papers were presented at

this conference, covering the areas of

Nuclear Energy and the Quality of Life, Fast

Breeder Reactors, Safety and Siting of

Established Power Reactor Types, Fuel Cycle,

Thermal Reactor Power System, Fusion Reactor

Engineering, and Sortable International

Safeguards. (JNC)

AVAILABILITY: American Nuclear Society (932.00)

Amer. Nuc. Soc. Trans., v15, no.2, Nov.1972.

THE FAST BREEDER REACTOR: SIGNS OF A CRITICAL
REACTION.

A.I. Hammond.

Science, v.176, Apr.28,1972, p.391-393.

1971
THE FAST BREEDER REACTOR: A SOURCE OF ABUNDANT POWER
FOR THE FUTURE.

H. Dieckamp.

Trans. Amer. Geophys. Union, v.52, no.11, 1971,
p.756-767.

N69-38243/ Commonwealth Edison Co., Chicago, Ill.

UTILITY REQUIREMENTS IN FAST BREEDERS

C. B. Zitek / In Am. Nucl. Soc. Fast Reactor Systems Mater. and

Components [1969] p.454-458

Avail. CFSTI

The economic requirements for the development of fast breeder

power reactors are analyzed as seen by the utility company.

NSA

A THIRD GENERATION OF BREEDER REACTORS.

T.R. Bump.

Scientific Amer., v.216, no.5, May 1967, p.25-33.

The evolution of fission reactors capable of
breeding more fuel than they consume in continuing.
The present plan is to develop a plant that will
generate a million kilowatts of electric power.

HIGH-DENSITY FUSION: A report by the Lawrence Livermore Laboratory of possible magnetic field designs to achieve thermonuclear fusion at high plasma density. 26 pages. (Report UCID-16371, available through AEC/contractor channels or at \$3.50 from NTIS, U.S. Department of Commerce, Springfield, Va., 22151.)

SHOPPING LIST FOR FUSION

LF Staff Report.

Laser Focus, May 1974, p.10,12,14,16,18,20,22.

Seeking help from outside the government, the AEC gives a revealing report of the status of laser-driven fusion. Help is most needed, it seems in high-power laser technology, in laser-target interactions and in diagnostics. An LF staff report

LASERS BLAST A SHORTCUT TO THE ULTIMATE ENERGY SOLUTION.

L. Lessing.

Fortune, May 1974, p.221-223,322,326,328,330.

Well before the year 2000, they could enable man to duplicate the thermonuclear process that fires the sun. One big obstacle is shortsighted public policy.

Environment & Change, v.2, no.5, Jan.1974.

THERMONUCLEAR FUSION POWER 329

K. V. Roberts

If controlled thermonuclear fusion is successful it will provide a clean, safe and cheap source of electrical power for an almost indefinite period. A commercial fusion reactor is however unlikely to be available much before the end of the century, and in the meantime it appears necessary to build up a world energy economy based on nuclear fission which is already a practical reality. The potential hazards of such a course suggest that it would be prudent to develop the alternative thermonuclear approach as rapidly as possible as an insurance policy. The views expressed in this article are those of the author.

TITLE: Fusion Reactor Technology Studies at ORNL
AUTHOR: Steiner, D. (Coordinator)
COMPANY: AUTOM; Oak Ridge National Laboratory, Thermonuclear Division, Fusion Reactor Technology Group

ADDRESS: P.O. Box 1, Oak Ridge, TN 37830

PUBLICATION DESCRIPTION: Report No. ORNL-TN-8439, 61 p., 12 references

PUBLICATION DATE: 1978, January

SPONSOR: U.S. Atomic Energy Commission, Division of Controlled Thermonuclear Research; U.S. Atomic Energy Commission, Division of Physical Research

ABSTRACT: This report reviews the Fusion Reactor Technology Studies at Oak Ridge National Laboratory for the period June 1972 to October 1973. The studies include the following: chemical engineering studies, tritium separation technology, hydrogen permeation through structural metals, effects of strong magnetic fields on molten salts; materials research on neutron and ion radiation damage and chemical compatibility of materials; neutronics research on tritium breeding, magnet shield design, vanadium as a structural material, cross sections; and system studies on blanket development, magnetohydrodynamic problems of the blanket, and an assessment of the power balance in fusion reactors. (NPG)

Fusion power — an assessment of its potential impact in the USA

Gerald L. Kulcinski

The prospects for harnessing power through the fusion of light nuclei have by turns looked doubtful and hopeful since the first research was conducted some 20 years ago. When might fusion begin to make a significant contribution to electricity generation and what will be the economic and environmental consequences? Dr Kulcinski presents possible answers to these questions and also highlights difficulties that could arise in the cost and availability of refractory metals and alloying elements for construction of magnetically-confined plasma reactors.

HARNESSING NATURE'S ULTIMATE ENERGY SOURCE.
Staff Report.
Optical Spectra, v.8, no.5, May 1974,
p.27-32.

Fusion researchers in laboratories are getting close to answering the feasibility question, and others are taking a new look at our oldest energy source, the sun.

FUSION POWER BY LASER IMPLOSION.

J.L. Emmett, et al.

Scientific American, v.230, no.6, June 1974,
p.24-37.

Laser fusion schemes are based on the ignition of a pellet of fuel by laser beams. For the laser approach to succeed the fuel must be imploded to 10,000 times normal liquid density.

Ways to controlled thermonuclear fusion. Wobig, Horst (Max-Planck-Inst. Plasmaphys., Garching/Munich, Ger.). *Naturwissenschaften* 1974, 61(3), 97-106 (Ger). A review with 52 refs. concerning laser fusion, toroidal confinement, and mirror machines.

Technology of Controlled Thermonuclear Fusion Experiments and the Engineering Aspects of Fusion Reactors.

Technical Information Center (AEC), Oak Ridge, Tenn. Apr 74, 1056p ISBN-0-87079-010-7
CONF-721111 PC\$16.60/MF\$1.45

The report presents presentations of a thermonuclear fusion symposium on feasibility experiments; electrical storage and handling for fusion experiments; diagnostic and control instrumentation; magnet and vacuum systems; engineering design of reactor blankets; plasma fueling, heating, ignition, and recovery systems; materials considerations; energy conversion schemes; and reviews of several international programs.

TITLE: Fusion Power: An Assessment of Ultimate Potential
AUTHOR: Peacock, A. (Chairman)
CORPORATE AUTHOR: U.S. Atomic Energy Commission, Div. of Controlled Thermonuclear Research
PUBLICATION DESCRIPTION: Report No. WASH-1239, 62 p.

PUBLICATION DATE: 1973, February
ABSTRACT: The ultimate potential of fusion power is evaluated using a set of reference designs for full scale fusion reactors based on the deuterium-tritium fuel cycle. One design, the Reference Controlled Thermonuclear Reactor, was analyzed specifically. Considered in the appraisal were the following: inherent characteristics of fusion power systems; method of assessment; probable environmental characteristics during normal operation; effects on non-renewable resources; fusion power economics; accident hazards; reliability and vulnerability; and matters related to national security. The report indicates that central station fusion power might become commercial about the year 2000. (MPC)

AVAILABILITY: GPO (\$3.90)

N74-10685# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
LASERS AND THE PROBLEM OF CONTROLLED THERMONUCLEAR SYNTHESIS

N. G. Basov and O. N. Krokhin 29 Aug. 1973 13 p Transl. into ENGLISH from *Budushcheye Nauki* (USSR), no. 5, 1972 p 107-113
 (FTD Proj. T74-01-42)

(AD-766973; FTD-HT-23-705-73) Avail: NTIS CSCL 20/9
 The report reviews laser beam heating of plasmas to obtain controlled thermonuclear reactions.

THE PROMISE OF FUSION POWER.

W.C. Gough.

The Futurist, Oct. 1973, p.211-215.

Thermonuclear fusion can help solve many of the world's most pressing problems--electric power shortages, dwindling supplies of portable fuels like gasoline, mounting mineral costs, and environmental pollution. Assuming a stepped-up research program, commercial electric power from fusion could be available by the year 2000.

TITLE: Foreseeable Thermal, Mechanical, and Materials Engineering Problems of Fusion Reactor Power Plants
AUTHOR: Fraas, A.P.
CORPORATE AUTHOR: Oak Ridge National Laboratory, Reactor Division
ADDRESS: P.O. Box 1, Oak Ridge, TN 37830
PUBLICATION DESCRIPTION: Paper presented at the 2nd International Conference on Structural Mechanics in Reactor Technology, Berlin, (West) Germany, September 10-14 1973, 30 p., 25 references

PUBLICATION DATE: 1973

SPONSOR: U.S. Atomic Energy Commission
ABSTRACT: The engineering problems that will be posed by full-scale fusion reactor power plants are illustrated by examining a representative conceptual design. The temperature extremes that must be accommodated run from a K in superconducting magnets to 1000°K in the plasma. These temperature differences lead to difficult problems with differential thermal expansion, high heat fluxes, and stringent thermal insulation requirements. The magnetic fields that must be provided run from 25 kg to 100 kg, and these fields induce forces on elements of the structure of the order of 20,000 tons. The walls of the chamber containing the plasma must withstand intense radiation by 14 mev neutrons and 1 to 50 kev ions. Unusual fluid flow and heat transfer problems include two-phase boiling flow of helium in the superconducting magnets, and the magnetohydrodynamic effects on the flow of red hot lithium and boiling potassium in a high magnetic field. These and many other problems must be solved in such a way as to give a reliable, safe system at a reasonable capital cost, and this must be done with materials whose nuclear, physical, and fabrication properties and resistance to corrosion meet all of the requisite boundary conditions. (Aeth)

A73-17667* # Review of controlled fusion research using laser heating. A. Hertzberg (Washington, University, Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-258*, 44 p. 63 refs. Members, \$1.50; nonmembers, \$2.00. NSF Grant No. GK-28562; Contract No. AT(45-1)-2225; Grant No. NGR-48-002-044.

Development of methods for generating high laser pulse energy has stimulated research leading to new ideas for practical controlled thermonuclear fusion machines. A review is presented of some important efforts in progress, and two different approaches have been selected as examples for discussion. One involves the concept of very short pulse lasers with power output tailored, in time, to obtain a nearly isentropic compression of a deuterium-tritium pellet to very high densities and temperatures. A second approach utilizing long wavelength, long pulse, efficient gas lasers to heat a column of plasma contained in a solenoidal field is also discussed. The working requirements of the laser and various magnetic field geometries of this approach are described. (Author)

CN-140.531

1973

FUSION POWER: RESEARCH AND DEVELOPMENT REQUIREMENTS. July 1973. 34p. & app.

Atomic Energy Commission

WASH-1267

ABSTRACT: This report discusses the fusion research program of the Atomic Energy Commission, what is being done to achieve scientific feasibility, and the research and development needs of the program. The four general approaches now receiving major emphasis are the steady state toroidal systems, magnetic mirror systems, pulsed high-beta pinch systems, and laser-fusion systems. The status and projected steps to scientific feasibility of each of these systems are described, along with supporting research and development and major planning assumptions. The effect of fusion power on the Reference Energy System provided by the Federal Council on Science and Technology is discussed in an appendix.

AVAILABILITY: GPO (\$1.90)

HD Institute of Electrical and Electronics Engi-1973
9540.4 neers International Convention and Exposition.
.15 1973.

1973 Prospecting for energy; 1973 IEEE Intercon
technical papers. [New York, Institute of
Electrical and Electronics Engineers, 1973]
1 v. (various pagings) illus. 28 cm.

6/2 Laser Initiated Fusion — Its Problems and Promises.

Keith Boyer, University of California, Los Alamos, N. M.

The release of thermonuclear energy in a controlled manner with its promise of providing a relatively clean and inexhaustible supply of energy is receiving an increasing amount of interest and attention. Shortly after the laser's invention it was recognized that this device could, in principle, provide the concentration of energy necessary to initiate the thermonuclear burning of the appropriate fuel, but only within a very small volume due to the limitation in total laser energy which might be achieved in a practical device. However, to achieve a sufficient thermonuclear energy return for the laser energy invested it was evident that efficient burning of the fuel would be required. With these limitations in mind, a study of the physics of the processes involved led to the concept of compressing the fuel to high density in an imploding system.

CN-129,601, No. 486, Audiotape (1973)

MEN AND MOLECULES. THE FUSION TORCH. B. Eastlund and W. Gough. (Radio Series 486). (1973). (Audiotape)

American Chemical Society
American Chemical Society

Radio Series 486

Thermonuclear equipment
Power sources, Nuclear
Audiotapes - Thermonuclear
Audiotapes - ACS

CN-129,601, Nos. 582 & 583 (1973)
MEN AND MOLECULES. SIDE I: FUSION: PROSPECTS AND
PITFALLS. H. Furth and H. Forsen. (Radio
Series 582). SIDE II: FUSION: PROSPECTS AND
PITFALLS - II. H. Furth and H. Forsen. (Radio
series 583). (1973). (Audiotape).

American Chemical Society Radio Series 582
American Chemical Society Radio Series 583
American Chemical Society

Audiotapes - Thermonuclear equipment
Thermonuclear reactions
Power sources, Nuclear 193,264

CLOSED HELIUM-TURBINE CYCLE WITH A FUSION REACTOR.
S. Forster.

Mechanical Engineering, Aug.1973, p.13-18.

Special problems in adapting the helium Brayton
cycle as an energy-conversion system for fusion
reactor power plants.

Power from Laser-Initiated Nuclear Fusion

By KEITH BOYER
Los Alamos Scientific Laboratory, UCLA

Design studies now in progress aim at a 10-kJ module that could provide the basis for a 100-kJ CO₂ laser system

Astronautics & Aeronautics, v.11, no.8, Aug.1973, p.50-

Nuclear Fusion by Magnetic Confinement

By R. F. POST
UC Lawrence Livermore Laboratory

By the early '80s the field should have solved the remaining questions of scientific feasibility for fusion reactors based on the principle of magnetic confinement and charted the course for engineering development of practical power generators

TITLE: Cryogenic Engineering and Fusion Power
AUTHOR: Taylor, C.E.
CORPORATE AUTHOR: Lawrence Livermore Laboratory
ADDRESS: University of California, Livermore, Ca
PUBLICATION DESCRIPTION: Report No. UCL-78935,
paper presented at Cryogenic Engineering
Conference, August 8-10, 1973, Atlanta, Ga,
17 p.

PUBLICATION DATE: 1973, August 6
SPONSOR: U.S. Atomic Energy Commission
ABSTRACT: The engineering problems involved in the scale-up of fusion devices to fusion power plants are briefly described. Special attention is given to the construction of large, cryogenic magnets. The large amounts of helium required may require extraction of helium from the atmosphere, an expensive process. (JMR)

N74-12245# Sandia Labs., Albuquerque, N.Mex.
LASER FUSION *ALAO CN-140,390*
R. E. Palmer [1973] 7 p. Sponsored by AEC
(SLA-73-5352) Avail: NTIS HC \$3.00
The application of lasers for sustaining controlled fusion is discussed. The basic conditions necessary to achieve fusion are described along with two other possible techniques, namely, electromagnetic confinement and electron beam heating. The principal problems facing fusion research and the future of laser fusion are described. NSA

1973

TITLE: Survey of the USABC program is controlled.
Thermonuclear Research
AUTHOR: Robbins, L.W. (Ed.)
CORPORATE AUTHOR: Principia College
PUBLICATION DESCRIPTION: Report no. WASH 1277, 76 p.
PUBLICATION DATE: 1973 ?
SPONSOR: U.S. Atomic Energy Commission, Division of Controlled Thermonuclear Research
ABSTRACT: This booklet is intended to provide a general description of the fusion research program of the U.S. Atomic Energy Commission's Division of Controlled Thermonuclear Research.----By its nature this booklet is necessarily incomplete. Not every experiment can be presented, nor can every sub-program be summarized. Work sponsored by other U.S. Government agencies has not been included, nor has the laser-fusion research sponsored by the AEC's Division of Military Application been described. It is intended that the booklet serve as a description of on-going research but that it not provide comment on the status of each effort. For this, the reader is referred to publications in the scientific literature. (Auth, from Introduction)
AVAILABILITY: U.S. Atomic Energy Commission, Div. of Controlled Thermonuclear Research, Washington, DC 20545

CN-129,601, Nos. 514 & 537, / (1973)
MEN AND MOLECULES. SIDE I: FUSION AND FISSION: AN APPRAISAL. James L. Tuck. (Radio Series 514). SIDE II: THE PROSPECTS FOR ENERGY. M. King Hubbert. (Radio Series 537). (1973). (Audiotape)

American Chemical Society
American Chemical Society
American Chemical Society

Power sources, Nuclear
Thermonuclear equipment
Audiotapes - Power sources, Nuclear

L99,252
1-3-15-74

HD 9540.4
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1973
Institute of Electrical and Electronics Engineers International Convention and Exposition 1973.

Prospecting for energy; 1973 IEEE Intercon technical papers. [New York, Institute of Electrical and Electronics Engineers, 1973] 1 v. (various pagings) illus. 28 cm.

6/1
Nuclear Fusion by Magnetic Confinement.

R. F. Post, University of California, Livermore, Ca.

The concept of a nuclear fusion reactor based on magnetic confinement is becoming scientifically credible, following two decades of research devoted to the solution of complex problems in plasma physics. Bar- ring setbacks, current research programs surveyed in this paper could lead to demonstrations of scientific feasibility within a decade. Although the present re- search is concentrated on the confinement problem, in- creasing consideration is being given to the engineer- ing and technology problems expected to arise in the design of fusion reactors based on the three main pre- sent approaches to the fusion confinement problem. These approaches are: 1) closed or toroidal systems of the "tokamak" type, 2) pulsed high density systems called "theta-pinch", and 3) open-ended magnetic con- figurations utilizing the magnetic mirror principle for plasma confinement. The status, remaining prob- lems, and potential as a reactor of each of the above approaches is discussed.

FUSION REACTORS - THE ULTIMATE SOLUTION?

M. Kenward.

Science New Scientist, v.60, no.878, Dec.27,1973, p.896-99.

Controlled thermonuclear fusion could guarantee our energy supplies from the 21st century onwards. Fusion research is now making its next tentative step forward.

(TID)-26528, pp 169-219) ADVANCED NUCLEAR POWER, Chapter IV. Bethe, H. A. (Cornell Univ., Ithaca, NY), Dec 1973.

In report of the Cornell workshops on the major issues of a national energy research and development program, September 14, 1973 - October 17, 1973.

The view is presented that the fast breeder and the fusion reactor are the only forms of technology now in sight that will give long-range, ample sources of energy. The feasibility of fusion has not been established. The LMFBR progress has been slow. High-grade uranium ore sources may become short in two to three decades if the ores continue to be needed in LWRs, etc. So with the technology of the breeder at hand, it is urgent that these be developed now. The most important characteristic of the breeder is the doubling time, the time it takes for the amount of fissile material to double. Technological, safety, and economic comparisons of the breeder and fusion reactors are made. Research on laser fusion and fusion by magnetic confinement are discussed with the laser fusion military applications indicated. Uranium ores; breeder calculations; the Doppler effect; Doppler effect and hypothetical accident; brief history of the breeder; history of laser-fusion; and future demand for uranium ore are subjects covered in the appendices. (NCW)

A73-17667 * # Review of controlled fusion research using laser heating. A. Hertzberg (Washington University, Seattle, Wash.). American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973. Paper 73-268. 44 p. 63 refs. Members, \$1.50; nonmembers, \$2.00. NSF Grant No. GK-28562; Contract No. AT(45-1)-2225; Grant No. NGR-48-002-044.

Development of methods for generating high laser pulse energy has stimulated research leading to new ideas for practical controlled thermonuclear fusion machines. A review is presented of some important efforts in progress, and two different approaches have been selected as examples for discussion. One involves the concept of very short pulse lasers with power output tailored, in time, to obtain a nearly isentropic compression of a deuterium-tritium pellet to very high densities and temperatures. A second approach utilizing long wavelength, long pulse, efficient gas lasers to heat a column of plasma contained in a solenoidal field is also discussed. The working requirements of the laser and various magnetic field geometries of this approach are described. (Author)

(WASH-1281-11) FUSION ENERGY PROGRAM. Subpanel Report XI Used in Preparing the AEC Chairman's Report to the President. Hirsch, R. L. (USAEC, Washington, D. C.). 27 Oct 1973. 320p. Dep. NTIS \$19.00.

The present and proposed national program explores a number of possible approaches to fusion power that can generally be placed in two categories: (1) magnetically contained plasma and (2) laser fusion systems. In (1), receiving 54% of the effort, three types of devices are considered most important: (1) the tokamak, (2) the theta pinch, and (3) the magnetic mirror. The tokamak is the primary concept, receiving about 60% of the present effort, while the other two concepts represent about 20% each. Laser fusion is in an early phase, so that it is possible that in the next few years dramatic progress could occur, or in the opposite extreme, a long systematic research effort may be found necessary. The proposed R and D budget for magnetic confinement shows increasing year-by-year fiscal 1975 through 1979 outlays of \$133 through \$398 million (total \$1.44 billion) for operating equipment, and construction. The laser-fusion budget shows a FY 1975-1979 total of \$110 million; this represents an addition for civilian laser fusion research above and beyond a 5-year projected military laser-fusion program totaling \$329 million. (LMT)

N74-19290# Flinders Univ., Bedford Park (Australia). School of Physical Sciences.

CONTROLLED FUSION RESEARCH Progress Report
M. H. Brennan Sep. 1973 21 p refs
(FUPH-G-4) Avail: AEC Depository Libraries HC \$3.25

The current status of the international research program directed towards developing a fusion reactor for electricity production is assessed. Information is obtained mainly from meetings of the International Fusion Research Council (July 29 and Aug. 1, 1973) and the Sixth European Conference on Controlled Fusion and Plasma Physics held in Moscow from July 30 to August 3, 1973. The major items of business discussed at the meeting of the International Fusion Research Council are presented and the various national research programs are outlined. Finally, the Australian program is considered. NSA

N74-20373# Catholic Univ. of America, Washington, D.C.
FUSION PLASMA CONVERSION Summary Progress Report.
1 Apr. 1972 - 31 Mar. 1973

Cyde L. Cowan 31 Mar. 1973 11 p
(Contract N00014-67-A-0377-0015; NR Proj. 099-401)
(AD-773937) Avail: NTIS CSCL 20/9

The ultimate objective of the research effort being carried on around the world is the achievement of a useful level of power output from a thermonuclear plasma. A new scheme for a fusion device was designed. This design, beginning with the simple desire to eliminate the need for coping with plasma instabilities in an essentially static, hot compressed plasma, led to the concept of dynamic containment. In this scheme, the plasma is contained in a continuously maintained magnetic field generated by three alternating fields. Heating is accomplished through a series of successive shocks combined with ohmic heating by plasma currents. Such a cyclic device would be continuously running, meeting the Lawson criterion over a number of cycles, on the average. GRA

A FUTURE ICE (THERMONUCLEAR THAT IS).

E. Teller.

IEEE SPECTRUM, Jan.1973, p.60-64.

The idea of building "modern internal combustion engines" (ICE) based on controlled thermonuclear fusion.

THE ENERGY CRISIS, PART I: LASERS AND FUSION.
Optical Spectra, v.7, no.2, Feb.1973, p.27-34.

Some aspects of controlled fusion by use of lasers. R. E. Kidder (Univ. California, Livermore, USA).
Proceedings of the Esfahan Symposium on Fundamental and Applied Laser Physics, Esfahan, Iran, 29 Aug. - 5 Sept. 1971 (Chichester, Sussex, England: Wiley-Interscience 1973), p.107-18.
The application of lasers to controlled fusion is considered, particular attention being given to fusion reactors based on laser-heated DT pellets. The requirements a laser must meet to be useful for this purpose are discussed. A decoupling effect resulting from the fact that long wavelength light can only penetrate and heat plasma electrons at relatively low density is described, which suggests that light of wavelength as great as 10 μ may not be suitable for pellet heating. (4 refs.)

THE ROAD TO CONTROLLED THERMONUCLEAR FUSION.
L. Artsimovich. USSR Academy of Sciences.
Nature, v.239, Sept.1,1972, p.18-22.

Presents state of research into controlled thermonuclear fusion and assesses its prospects.

Computer Applications in Controlled Thermonuclear Research.
John Killeen.
California Univ., Livermore. Lawrence Livermore Lab. 15
Aug 73. 15p
UCRL-51439 PC\$4.00/MF\$1.45

The report surveys those areas of plasma physics and controlled thermonuclear research in which computation has made significant contributions. Both fluid and particle models are considered and applications to specific confinement experiments and plasma theory are discussed. (Author)

THE TOKAMAK APPROACH IN FUSION RESEARCH.

Bruno Coppi and Jan Rem.

Scientific American, July 1972, p.65-75.

Experimental studies of plasma heating and confinement in machines based on the Tokamak design, a 'toroidal diffuse pinch' configuration, are being conducted and planned in laboratories around the world.

1972

1972

TITLE: Environmental Aspects of Fusion Power Plants
AUTHOR: Fraas, A.P.
CORPORATE AUTHOR: Oak Ridge National Laboratory
ADDRESS: P.O. Box X, Oak Ridge, TN 37830
PUBLICATION DESCRIPTION: Paper presented at International Conference on Nuclear Solutions to World Energy Problems held November 13-17, 1972, Washington, DC, p. 261
PUBLICATION DATE: 1972
SPONSOR: U.S. Atomic Energy Commission
ABSTRACT: The possible environmental impact of fusion reactor power plants is summarized. The questions associated with fuel supply, structural and coolant materials, safety aspects, tritium leakage, liquid metal leaks, inventory of radioactive materials, major accidents, air and water pollution, and thermal pollution are examined. None of these are considered a serious barrier in the operation of the ultimate system which will be developed. (JNC)
AVAILABILITY: American Nuclear Society, 2nd East Ogden Ave., Hinsdale, IL 60521 (\$32.00 for entire proceedings)

TITLE: Fusion Power: Past, Present and Future
AUTHOR: Hirsch, R.L.
CORPORATE AUTHOR: U.S. Atomic Energy Commission, Division of Controlled Thermonuclear Research
PUBLICATION DESCRIPTION: Paper presented at an International Conference on Nuclear Solutions to World Energy Problems held November 13-17, 1972, Washington, DC, p. 216-225
PUBLICATION DATE: 1972
ABSTRACT: In the early 1950's and the fusion program began independently in the United States, the United Kingdom, and Russia. The early work proved that known technology could not be extrapolated to this problem. Much work through the 1960's involved a study of the basic science of plasma physics. At the present four basic methods are being pursued to solve the problems of plasma heating, plasma confinement, and technology development. The demonstration of scientific feasibility should occur around 1980 and fusion power commercialization around 2000. (JNC)
AVAILABILITY: American Nuclear Society, 2nd East Ogden Ave., Hinsdale, IL 60521 (\$32.00 for entire proceedings)

TYPE 16/2/2
74N71146# BNWL-B-162 AT(45-1)-1830 72/02/23 15 PAGES
UNCLASSIFIED DOCUMENT

FUSION-FISSION (HYBRID) SYSTEMS: A CONTRIBUTION TO THE POST REPORT ON ASSESSMENT OF ENERGY TECHNOLOGIES
LEONARD, B. R., JR.; B/WOLKENHAUER, W. C.
BATTELLE-NORTHWEST, RICHLAND, WASH. AVAIL.NTIS
♦NUCLEAR FUSION♦NUCLEAR REACTORS♦ ECONOMIC FACTORS♦ ENERGY SOURCES

TK Intersociety Energy Conversion Engineering
2896 Conference, 7th, San Diego, Calif., 1972.
155 Proceedings. Washington, D. C., American
1972 Chemical Society, 1972.
1533 p. illus. 28 cm.

A Lithium Cooled Toroidal Fusion Reactor. J. T. D. Mitchell, R. Hancox. 1275
Design Study of a Pulsed High-Beta Fusion Reactor
S. C. Burnett, W. R. Ellis, T. Oliphant, F. L. Ribe 1284

University of Wisconsin Fusion Design Studies, C. W. Maynard, H. K. Forsen 1288
Neutronics of Sub-critical Fast Fission Blankets for D-T Fusion Reactors, J. D. Lee 1294

1972

LASER IMPLOSION: WILL IT SPEED FUSION TIMETABLE.
TECHNOLOGY FORECASTS, v.4, no.9, Sept.1972, p.1-3.

see also PHYSICS TODAY, Aug.1972, p.17-20.

TK Institute of Electrical and Electronics Engineers.
6540 1972 IEEE international convention digest.
.I 445 New York, 1972. 559 p. illus. 28 cm.
1972 "Synopsis of Papers Presented at the 1972
IEEE International Convention March 20-23, 1972,
New York, N. Y."
"IEEE cat. no. 72 CMO 581-9 IEEE."

Status and Outlook for Controlled
Thermonuclear Power, R. G. Mills..... 142

FUSION POWER.

L. Wood and J. Nuckolls.
Environment, v.14, no.4, May 1972, p.29-33.

1972

TITLE: Fusion Reactor Systems
AUTHOR: Rife, P.L.
CORPORATE AUTHOR: Los Alamos Scientific Laboratory
ADDRESS: Los Alamos, NM
PUBLICATION DESCRIPTION: Paper presented at
International Conference on Nuclear Solutions
to World Energy Problems held November 13-17,
1972, Washington, DC, p. 226 - 239, 19
references

PUBLICATION DATE: 1972
SPONSOR: U.S. Atomic Energy Commission
ABSTRACT: A description, with explanatory
drawings, is given for each of the four types
of fusion reactors now being studied in this
country. The Tokamak reactors are studied at
Oak Ridge and Princeton; the Theta-pinch at
several universities; the Mirror at Lawrence
Livermore; and the Laser-pellet at Los Alamos
and Oak Ridge. The design features of
conceptual reactors of each type are
described. (JNC)
AVAILABILITY: American Nuclear Society, 200 East
Coden Ave., Hinsdale, IL 60521 (\$32.00 for
entire proceedings)

1972

N72-32521# Los Alamos Scientific Lab., N.Mex. Advanced
Concepts Group.
CENTRAL STATION POWER GENERATION BY LASER-
DRIVEN FUSION
L. A. Booth, comp. Feb. 1972 62 p
(Contract W-7405-eng-38)
(LA-4858-Vol-1) Avail: NTIS

The feasibility of using laser-driven fusion pulses for the
commercial generation of electric power was investigated.
Results are presented in two volumes. Volume 1 (LA-4858-MS,
Uncl.) discusses the general aspects of electric power plants
based on laser-driven fusion energy sources, outlines the
considerations that led to the wetted-wall concept on which the
present study is based, presents detailed results of calculations
that indicate the feasibility of the concept, discusses aspects of
important areas that are not well defined, summarizes related
needs for further study, and compares the concept with plants
based on magnetically confined controlled thermonuclear
reactions. Volume II (LA-4859-MS, Classified, SRD) outlines
LASL's laser program, discusses the problems of achieving
laser-driven fusion, considers subsequent neutronic interactions,
and gives some economic implications.
Author (NSA)

1972

1972

TITLE: Major Technological Problems for Fusion Reactor Power Stations
AUTHOR: Kulcinski, G.L.
CORPORATE AUTHOR: University of Wisconsin
ADDRESS: Madison, WI 53706
PUBLICATION DESCRIPTION: Paper presented at International Conference on Nuclear Solutions to World Energy Problems held November 13-17, 1972, Washington, DC, p. 240-259, 66 references
PUBLICATION DATE: 1972
ABSTRACT: The major problems areas associated with the four objects of fusion reactor research are outlined. These objects are: confine and sustain fusion reactions, 5 fission areas; convert kinetic energy of fusion products into electricity, 6 problem areas; breed new fuel, 2 problem areas; and be competitive with other energy sources, 2 problem areas. The fact that some of the biggest problems are economic in nature is encouraging. (JNC)
AVAILABILITY: American Nuclear Society, 244 East Ogden Ave., Hinsdale, IL 60521 (\$32.00 for entire proceedings)

N73-12707# Nowak (K.), Vienna (Austria).
PROJECT FOR OBTAINING CONTROLLED NUCLEAR FUSION. A NEW SYSTEM THAT SHOULD LEAD TO RAPID PRACTICAL USE FOR ENERGY PRODUCTION BY CONTROLLED NUCLEAR FUSION
K. Nowak (1972) 16 p. refs In GERMAN (NP-19152) Avail: AEC Depository Libraries
The method described should make possible the technical evaluation of controlled nuclear fusion with positive energy balance and high efficiency for the energy production and, by creation of defined ratios, avoid the origin of neutron or tritium emission. For this method, the brief collision of plasmas of high ion density formed from accelerated deuterium ions and electrons was proposed. The selected pulse times and accelerations permit the greatest possible efficiency of the fusion process. The bias against obtaining controlled nuclear fusion by collision of accelerated ions was based on the previous ratios for pure ion beams of usual plasma densities, but is erroneous for plasma beams of high density.
Author (NSA)

LASERS AND CONTROLLED THERMONUCLEAR FUSION.
Nature, v.239, Sept.15,1972, p.129,130.

POTENTIAL ADVANTAGES OF FUSION POWER REACTORS.
R.G. Mills.
IEEE Trans. Nuc. Sci., v.NS-19, no.1, Feb.1972, p.10-14.

Some of the promises of fusion power are now coming true, and the prospect of fusion power is now a visible goal rather than merely a hope for the future.

LASER FUSION: A NEW APPROACH TO THERMONUCLEAR POWER.
W.D. Metz.
Science, v.178, Sept.29,1972, p.1180-1182.

MAGNETIC CONTAINMENT FUSION: WHAT ARE THE PROSPECTS?
Science, v.178, Oct.20,1972, p.291-293.

LASER COMPRESSION OF MATTER TO SUPER-HIGH DENSITIES: THERMONUCLEAR (CTR) APPLICATIONS.
J. Nuckolls, et al.
Nature, v.239, Sept.16,1972, p.139-142.

Hydrogen may be compressed to more than 10,000 times liquid density by an implosion system energized by a high energy laser. This scheme makes possible efficient thermonuclear burn of small pellets of heavy hydrogen isotopes, and makes feasible fusion power reactors using lasers.

FUSION ENGINEERING: Proceedings of a November, 1972 symposium at the University of Texas on the technology of controlled thermonuclear fusion experiments and the engineering aspects of fusion reactors. 1050 pages. (Report CONF-721111, available through AEC/contractor channels or at \$16.60 from NTIS, U.S. Dept. of Commerce, Springfield, Va. 22151.)

A72-36332 Pulsed power - A new technology for controlled thermonuclear fusion. L. S. Levine (U.S. Navy, Naval Research Laboratory, Washington, D.C.). In: Scanning the spectrum; Proceedings of the Tenth Annual Region 3 Convention, Knoxville, Tenn., April 10-12, 1972. New York, Institute of Electrical and Electronics Engineers, Inc., 1972, p. Q1-1 to Q1-7. 43 refs. Research supported by the Defense Nuclear Agency and U.S. Navy.

The development of pulsed power technology has now reached the point where it may be able to make a significant contribution to the quest for controlled thermonuclear fusion. Existing pulsed power generators can produce powers of the order of 1 TW for times of the order of .1 microsec. Such generators are most commonly utilized to produce intense relativistic electron beams, and this paper briefly surveys the existing state of the art of generators and relativistic beams. The paper also considers several of the methods that have been proposed for incorporating intense beams or pulsed plasma generators into controlled fusion schemes. (Author)

A72-43723 Laser-produced plasma and fusion yield. L. S. Dzung (Brown Boveri et Cie. AG, Baden, Switzerland). *Zeitschrift für angewandte Mathematik und Physik*, vol. 23, Mar. 25, 1972, p. 301-310. 8 refs.

Lubin and Fraas (1971) have reported an engineering approach for utilizing for electrical power generation a method of plasma production which is based on the heating of small pellets of fusible material by laser radiation. In this approach the fusion energy is absorbed as thermal energy by liquid lithium. The lithium provides the heat source for a conventional power plant. One of the crucial questions regarding this approach is concerned with the required energy of the laser pulse. The results produced by various previous investigations of the question show great differences. The problem is carefully analyzed, taking systematically into account the effects of changing parameters. A gasdynamic model combining reasonable physical accuracy with sufficient mathematical simplicity is discussed. G.R.

TITLE: Fusion Energy and the Future
AUTHOR: Gough, W.C.
CORPORATE AUTHOR: U.S. Atomic Energy Commission,
Division of Controlled Thermonuclear Research
ADDRESS: Washington, DC 20545
PUBLICATION DESCRIPTION: Part of
N.R.(24-1), "The Chemistry of Fusion
Technology". Plenum Press, New York, p. 1-50,
25 references

PUBLICATION DATE: 1972
SYNOPSIS: A long description, with illustrative graphs, is given of the development of the present day problems of material and energy deficiencies. Extrapolation of present trends into the future paints a dismal picture. Several basic changes in fundamental attitudes must be made to avoid this. Details of the present status of fusion technology are presented, together with the assistance it can provide in developing an equilibrium civilization. (JMC)
AVAILABILITY: Plenum Press, 227 West 17th St., New York, NY 10011 (\$19.50 for entire proceedings)

1972

TITLE: The Chemistry of Fusion Technology
 AUTHOR: Green, D.M. (ed.)
 CORPORATE AUTHOR: Argonne National Laboratory,
 Chemistry Division
 ADDRESS: Argonne, IL
 PUBLICATION DESCRIPTION: Proceedings of a
 Symposium on the Role of Chemistry in the
 Development of Controlled Fusion, an American
 Chemical Society Symposium, held in Boston,
 MA, April 1972, Plenum Press, New York, 396 p.
 PUBLICATION DATE: 1972

ABSTRACT: This book contains the text of 10
 symposium papers. The following papers were
 presented: Fusion Energy and the Future, by
 F.C. Gough; Tritium Breeding and Direct
 Energy Conversion, by J.D. Lee; A Review of
 the Chemical, Physical, and Thermal
 Properties of Lithium that are Related to its
 Use in Fusion Reactors, by E.J. Cairns, P.A.
 Cafasso, and V.A. Maroni; Molten Salts as
 Blanket Fluids in Controlled Fusion Reactors,
 by W.M. Grimes and S. Cantor; Fusion Reactor
 Fuel Processing, by E.P. Johnson; Chemical
 Effects of Plasma Interactions with
 Thermonuclear Reactor Surfaces, by D.M.
 Green; Diffusion and Permeation of Hydrogen
 Isotopes in Fusion Reactors, by R.E.
 Stickney; Condensed Phase Metal-Hydrogen
 Systems and Their Role in Controlled Fusion
 Reactors, by G.G. Libowitz; Chemical Aspects
 of New Superconducting Materials and
 Fabrication Techniques, by W.G. Bowman; and
 Experiments Leading to Laser Induced Fusion,
 by H.J. Labin. A subject index is provided.
 (APC)

AVAILABILITY: Plenum Press, 227 West 17th St.,
 New York, NY 10011 (\$19.50)

THE PROMISE OF CONTROLLED FUSION.
 R.G. Mills.
 IEEE Spectrum, Nov.1971, p.24-26.

Controlled fusion using long-wavelength laser heating with mag-
 netic confinement. J.M. Dawson, W.L. Kruer (Princeton Univ., N.J., USA),
 A. Hertzberg, G.C. Vlases, H.G. Ahlstrom, L.C. Steinhauer, R.E. Kridler.
 Proceedings of the Esfahan Symposium on Fundamental and Applied Laser
 Physics, Esfahan, Iran, 29 Aug. - 5 Sept. 1971 (Chichester, Sussex, England:
 Wiley-Interscience 1973), p.119-40
 The recent development of efficient high-pulse-power and high-energy 10.6- μ
 N₂-CO₂ lasers has created new and attractive possibilities for controlled fusion
 processes. In particular, by combining magnetic confinement techniques with
 this type of laser, new reactor configurations become feasible which are dis-
 cussed in the paper. The basic physics of these configurations is discussed and
 scaling parameters developed. Engineering problems are also explored. (38)

QC
 791
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 1972

International Conference on Plasma Physics and
 Controlled Nuclear Fusion Research, 4th,
 Madison, Wis., 1971.
 Plasma physics and controlled nuclear
 fusion research. Supplement-1972. [Vienna]
 International Atomic Energy Agency [1972]
 357 p. illus. 30 cm.
 Held 17-23 June 1971; sponsored by the
 International Atomic Energy Agency.

1971

IEEE Transactions on Nuclear Science
v. NS-18, no. 4

Aug.
1971

SYMPOSIUM ON EXISTING PROBLEMS OF FUSION RESEARCH,
PROCEEDINGS, 4th. (Sponsored by the Naval Research
Lab., AEC and IEEE). (Held at the Naval Research Lab.,
Washington, D.C., Apr. 20-23, 1971).

Naval Research Lab.
Atomic Energy Commission
Institute of Electrical and Electronics
Engineers
Symposium on Engineering Problems of
Fusion Research

Apr. 20-23,
1971
L-9-27-71

THE PROSPECTS OF FUSION POWER.

W.C. Gough and B.J. Eastlund.
Scientific American, v. 224, no. 2, Feb. 1971, p. 50-64.

Recent advances in the performance of several experi-
mental plasma containers have brought the fusion-
power option very close to the break even level of
scientific feasibility.

title: Outlook for Controlled Fusion Power

AUTHOR: Tech, J.L.
CORPORATE AUTHOR: Los Alamos Scientific Laboratory
ADDRESS: Los Alamos, NM
PUBLICATION DESCRIPTION: Nuclear Engineering
International, 16(1986), 928-930
PUBLICATION DATE: 1971, November
SPONSOR: U.S. Atomic Energy Commission
ABSTRACT: The first controlled nuclear fusion
device is expected to be developed about
1980. From that time it will probably
require 20 years to complete the first
commercial fusion reactor. The advantages
and disadvantages of the four types of fusion
devices now in the experimental stage are
presented. One item, often overlooked, is
the development of a fusion power network
the enormous quantity of helium that would be
required, if presently available technology
is used. (JMC)

see also: Nature, v. 233, Oct. 29, 1971, p. 593-598.

National Academy of Sciences
Proceedings, v. 68, no. 8, p. 1919-1943

Aug.
1971

SYMPOSIUM ON ENERGY FOR THE FUTURE-PROBLEMS AND
PROSPECTS. (Presented at the annual meeting of the
NAS, Apr. 1971).

National Academy of Sciences
Symposium on Energy for the Future -
Problems and Prospects

Apr.
1971

Energy for the future—problems and prospects
Introductory remarks
Initiatives for the future of energy
Electric power from nuclear fission
Fusion power
Power generation and the environment

FUSION BY LASER

M.J. Lubin and A.P. Fraas.

Sci. Amer., v. 224, no. 6, June 1971, p. 21-34.

NUCLEAR POWER: RISKS AND SOCIAL CONCERNS. p.19
NUCLEAR POWER: SOCIAL NEEDS AND BENEFITS. p.29
GLOBAL TEMPERATURE EFFECTS OF THE USE OF FUSION
ENERGY AND THE FUSION TORCH. p.31

A TECHNOLOGISTS RESPONSE TO PREDICTIONS OF CATA-
STROPHE. p.37

IEEE Trans. Nuc. Sci., v. NS-18, no. 1, Feb. 1971.

(17th Nuclear Science Sym. and 2nd Nuclear Power
Systems Sym., N.Y., N.Y., Nov. 4-6, 1970)

1970

QC
790
.S93
1970

Symposium on Fusion Technology, 6th, Aachen (Germany), 1970.
Proceedings. Luxembourg, Commission of the European Communities, General Directorate for Dissemination of Knowledge, Centre for Information and Documentation (CID), 1970.
v, 571 p. illus. 30 cm.
Held September 22-25, 1970.
At head of title: European Atomic Energy Community - EURATOM.
Organized by the Kernforschungsanlage Jülich Institut für Plasmaphysik.

QC
770
.I551
SUPPL.

International Atomic Energy Agency
Nuclear fusion: special supplement, 1970;
world survey of major facilities in controlled fusion. Vienna, 1970.
250 p. 24 cm.

CONTROLLED FUSION: PLASMA HEATING WITH LASERS.
Science, v.167, Feb.20,1970, p.1112-13.

N70-37097# Oak Ridge National Lab., Tenn.
PRELIMINARY APPRAISAL OF THE HAZARDS PROBLEMS OF A D-T FUSION REACTOR POWER PLANT
A. P. Fress and H. Postma May 1970 32 p refs
(Contract W-7405-eng-26)
(ORNL-TM-2822) Avail: CFSTI

A preliminary assessment of the hazards problems of a D-T fusion reactor was made to provide some notion of the seriousness of these problems in possible future applications of thermonuclear power plants. The inherent characteristics of magnetically confined plasmas appear to be such that any tendency toward general power overshoots or local hot spots will be more than compensated by other factors, so that there should be no difficulties with either general or local temperature or power excursions that might cause a meltdown or an explosion. In turning to radiological hazards, the principal source of concern is tritium. Fortunately, fusion reactor systems will ordinarily be designed so that the bulk of the tritium produced will be consumed as fuel. Thus, though the tritium production rate will run roughly 1000 times that in a fission reactor, by proper plant design the tritium inventory can be kept to about the same level as in a conventional fission reactor such as a PWR.

Author (NSA)

N70-38141# California Univ., Livermore. Lawrence Radiation Lab.
FUSION POWER: DIRECT CONVERSION AND THE REDUCTION OF WASTE HEAT
R. F. Post [1970] 16 p
(TID-25414) Avail: NTIS

Fusion reactors are discussed in the context of the direct conversion of fusion energy to electricity. The use of particles released from fusion reactors for the purpose of direct conversion is discussed. The use of different fuels and different conversion cycles is also discussed.
NSA

QC
791
.H5

Hulme, H R
Nuclear fusion [by] H.R. Hulme. London, Wykeham Pubs., distributed by Springer-Verlag New York, 1969.
vii, 155 p. illus. 23 cm. (Wykeham science series for schools and universities no. 4)

1. Controlled fusion. 2. Plasma (ionized gases)
I. Title. (Series)

1968

N70-37081# Atomic Energy Commission, Washington, D.C.
Div. of Research.
**THE FUSION TORCH: A NEW APPROACH TO POLLUTION
AND ENERGY USAGE**
Bernard J. Eastlund and William C. Gough 7 Nov. 1969 27 p
Refs Presented at 82d Ann. Meeting on Waste Treatment Appl.
of Radiation Chem., Washington, D.C., 16-20 Nov. 1969
(Conf-691108-2) Avail: CFSTI

A new concept is described for the handling of large volumes
of solid wastes in the future. The energy and material balance for
processing U. S. municipal wastes in the year 2000 via this
concept is compared with that for advanced incineration. Background
discussion of the properties of a fusion plasma and a future fusion
power system are given. Author (NSA)

TOWARDS THERMONUCLEAR FUSION.
Michail Romanovskii, Kurchatov Institute of Atomic
Energy, Moscow
Science journal, v.4, no.11, Nov.1968, p.43-48.

In attempts to harness the energy of thermonuclear
fusion ~~to~~ supply power, Soviet physicists at the
Kurchatov Institute have already produced the
densest and hottest man-made plasma. They are
also developing unconventional ways of containing
it.

1969

**ARTSIMOVICH TALKS ABOUT CONTROLLED-FUSION
RESEARCH.** J.L. Tuck.
Physics Today, v.22, no.6, June 1969, p.54-63.

Which approach to fusion looks best? A leading
member of the Soviet Academy evaluated progress
in the US and USSR and offered his own list
of priorities for fusion research.

1964

N65-24859 Texas Univ., Austin. Dept. of Electrical Engi-
neering
**PROBLEMS AND PROGRESS IN CONTROL OF THERMO-
NUCLEAR FUSION FOR ELECTRICAL POWER PRODUC-
TION**
Arwin A. Dougal /n Okla. State Univ. Proc. of the 2nd Ann.
Energy Conversion and Storage Conf., Oct. 12-13, 1964
[1964] 8 p refs (See N65-24850 14-03) Available from Okla.
State Univ.: \$5.00

The basic principles of controlled thermonuclear fusion
are summarized. Also, ion cyclotron resonances and waves in
thermonuclear plasmas, and theta-pinch thermonuclear plas-
mas are discussed as representative of present day research.
Further, the Faraday rotation method of infrared maser diag-
nostics is presented. Comparison of fusion approaches of the
theta-pinch, pyrotron, stellarator, ion injection, and linear
pinch methods are compared. Results show that the theta-
pinch is an order of magnitude better than other approaches.
Theta pinches are the best established means of producing
plasmas with kilovolt energies, with at least short term sta-
bility, and with a plasma pressure comparable to that of the
magnetic field. In the theta-pinch, the plasma is heated and
contained by a longitudinal magnetic field produced by a high-
current single turn coil.
E.E.B.

1152

9/74

CONTAINER SHIPS: OIL FUELED VERSUS NUCLEAR POWERED
 Nuclear Technology, v. 22, no. 2, May 1974, p. 196-
 Thomas B. Dade
 Warren F. Wilzig

Innovations in the maritime industry to increase ship productivity, along with the sharp rise anticipated for the cost of fossil fuel, call for a reappraisal of marine nuclear propulsion to meet the high power requirements of modern container ships. A recently designed oil-fueled, high-speed, quick-turnaround container ship was used as the base for a comparison to assess the economic feasibility of nuclear propulsion for ships of this type. To avoid inadvertent advantage to one or the other alternative, both were analyzed according to two independent economic criteria: (a) average annual operating costs, and (b) average annual net profit. Each of these criteria accounts for the significant costs incurred by the ship over its life, including the effects of taxes and the time value of money. The results of sensitivity computations indicate that the nuclear-powered container ship, as modified for this comparison, would now be competitive with the oil-fueled ship on transatlantic routes. A similar ship specifically designed for nuclear propulsion should have an economic advantage.

A74-20166 # The airship can meet the energy challenge. J. G. Vaeth (NOAA, National Environmental Satellite Service, Washington, D.C.). *Astronautics and Aeronautics*, vol. 12, Feb. 1974, p. 25-27.

It is suggested that lighter-than-air craft, in the form of very large airships, can be developed using nuclear propulsion. Such an airship can be designed to move cargo pieces weighing a million pounds and more into difficult-to-reach places at energy expenditures matching available resources. Inherent environmental cleanliness and quiet would be important fringe benefits. F.R.L.

NAVAL NUCLEAR PROPULSION PROGRAM, 1973-78.
 Hearings Before the Joint Committee on Atomic Energy, Congress of the United States, Ninety-Second Congress, Second Session, and Ninety-Third Congress, First Session. Testimony of Vice Admiral H. G. Rickover, February 9, 1973, Part I and March 28, 1973, Part II. Washington, DC: Joint Committee on Atomic Energy (1974). 283p. GPO \$2.25.

CM-129,652
 1973
 NUCLEAR PROPULSION. Jerry Grey. (Series title: AIAA Recorded Lecture Series). 1973.
 2 audiotapes - Tape 1 & Tape 2; 1 notebook - 44p.

American Inst. of Astronautics
 and Aeronautics

Audiotapes - Propulsion, Nuclear
 Rockets, Nuclear
 Ram-jets, Nuclear
 Airplanes, Nuclear

188,494
 L-6-12-73

N73-17991*# National Aeronautics and Space Administration.
 Lewis Research Center, Cleveland, Ohio.

NORTHWEST PASSAGE: TRADE ROUTE FOR LARGE AIR
 CUSHION VEHICLES

John L. Anderson Washington Mar. 1973 38 p refs
 (NASA-TM-X-2684; E-7211) Avail: NTIS HC \$3.00 CSCL
 OIC

A conceptual vehicle and powerplant (10,000-ton) nuclear-powered air-cushion vehicle (ACV) that could open the Northwest Passage and other Arctic passages to commercial traffic is identified. The report contains a description of the conceptual vehicle, including the powerplant and operations, an assessment of technical feasibility, estimates of capital and operating costs, and identification of eligible cargo and markets. A comparison of the nuclear ACV freighter with nuclear container ships shows that for containerized or roll-on/roll-off cargo the ACV would provide greatly reduced transit time between North Atlantic and North Pacific ports at a competitive cost.

Author

A74-17813 *# Assessment of lightweight mobile nuclear power systems. J. L. Anderson and F. E. Rom (NASA, Lewis Research Center, Cleveland, Ohio). *American Nuclear Society, Winter Meeting, San Francisco, Calif., Nov. 11-15, 1973, Paper, 34 p.* 45 refs.

After nearly two decades of study, analysis, and experiments relating to lightweight mobile nuclear power systems (LMNPS), it seems fitting to report the status and to assess some options for the future of this technology. This report: (1) reviews the technical feasibility studies of LMNPS and airborne vehicles; (2) identifies what remains to be done to demonstrate technical feasibility of LMNPS; (3) reviews missions studies and identifies particular missions that could justify renewed support for such technology; and (4) identifies some of the nontechnical conditions that will be required for the development and eventual use of LMNPS. (Author)

1972

197

A73-12596 # Dirigibles - Aerospace opportunities for the '70s and '80s. F. Morse (Boston University, Boston, Mass.), G. J. O'Hara (U.S. Navy, Naval Research Laboratory, Washington, D.C.), J. G. Vaeth (NOAA, National Environmental Satellite Service, Washington, D.C.), V. H. Pavlecka, and K. R. Stehling. *Astronautics and Aeronautics*, vol. 10, Nov. 1972, p. 32-40. 17 refs.

The dirigible or rigid airship, a versatile and potentially ecologically 'clean' STOL with exceptional payload capability, endurance, range, flight stability, and onboard roominess, deserves renewed consideration as a useful vehicle in tomorrow's scheme of things. It is pointed out that great improvements can now be made in the structure of the rigid airship because computers and modern structural dynamics permit the analysis of the ship's structure as a whole. The history of dirigibles is reviewed and new advances for future airships are considered. An exciting picture emerges when nuclear power propels a lighter-than-air craft. Onboard radar would help avoid obstacles and detect other aircraft. It would examine the ground for accurate navigation, provide weather surveillance, and assist mast-approach control in poor visibility. G.R.

A73-13391 # Engine technology for large subsonic nuclear powered aircraft. F. L. Robson and G. T. Peters (United Research Laboratories, East Hartford, Conn.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Specialist Conference*, 8th, New Orleans, La., Nov. 29-Dec. 1, 1972. *AIAA Paper 72-1062*, 9 p. Members, \$1.50; nonmembers, \$2.00. Contract No. F33615-71-C-1872.

Results of a technology review of the propulsion system of a large subsonic nuclear-powered aircraft. Low to moderate bypass ratio turbofan engines of 60,000 lb static thrust utilizing technology currently available in the JT9/CF6 jumbo-jet engines are the most suitable for use in a large subsonic aircraft. Such engines could be used with either gas-cooled or liquid-metal-cooled reactors. The analysis leading to selection of this type of engine is described, and conceptual design layouts of two engines are presented. (Author)

A72-15778 # Creating new cities through the large air-cushion vehicle. J. L. Anderson and P. M. Finnegan (NASA, Lewis Research Center, Nuclear Systems Section, Cleveland, Ohio). *Astronautics and Aeronautics*, vol. 10, Jan. 1972, p. 46-54. 21 refs.

The air-cushion vehicle (ACV) can travel over concrete roads, grass, sand, mud, swamp, snow, ice, and water. This mobility makes possible a totally new geographical freedom in choosing transportation routes, locating ports, and laying out a city. By the 1980s fleets of large ACV freighters could begin carrying ocean-going cargo. The mobility of an ACV fleet would allow placing hoverports away from areas now crowded. New cities could rise along shallow or reef-bound seacoasts and rivers, just as cities once rose around deep-water seaports. G.R.

454

A73-13390 * # Nuclear powerplants for mobile applications. J. L. Anderson (NASA, Lewis Research Center, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Specialist Conference*, 8th, New Orleans, La., Nov. 29-Dec. 1, 1972. *AIAA Paper 72-1061*, 34 p. 64 refs. Members, \$1.50; nonmembers, \$2.00.

Mobile nuclear powerplants for applications other than large ships and submarines will require compact, lightweight reactors with especially stringent impact-safety design. This paper examines the technical and economic feasibility that the broadening role of civilian nuclear power, in general, (land-based nuclear electric generating plants and nuclear ships) can extend to lightweight, safe mobile nuclear powerplants. The paper discusses technical experience, identifies potential sources of technology for advanced concepts, cites the results of economic studies of mobile nuclear powerplants, and surveys future technical capabilities needed by examining the current use and projected needs for vehicles, machines, and habitats that could effectively use mobile nuclear reactor powerplants. (Author)

N73-16642* # National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio. **POST IMPACT BEHAVIOR OF MOBILE REACTOR CORE CONTAINMENT SYSTEMS**

Richard L. Puthoff, W. G. Parker (Westinghouse Electric Corp., Pittsburgh), and L. E. VanBibber (Westinghouse Electric Corp., Pittsburgh). 1972. 31 p. refs. Presented at the Ann. Meeting of the Am. Nucl. Soc., Las Vegas, Nev., 18-22 Jun. 1972. (NASA-TM-X-68176; L-6283) Avail: NTIS HC \$3.75. CSCL 18J

The reactor core containment vessel temperatures after impact, and the design variables that affect the post impact survival of the system are analyzed. The heat transfer analysis includes conduction, radiation, and convection in addition to the core material heats of fusion and vaporization under partially burial conditions. Also, included is the fact that fission products vaporize and transport radially outward and condense outward and condense on cooler surfaces, resulting in a moving heat source. A computer program entitled Executive Subroutines for Afterheat Temperature Analysis (ESATA) was written to consider this complex heat transfer analysis. Seven cases were calculated of a reactor power system capable of delivering up to 300 MW of thermal power to a nuclear airplane. Author

N72-11844* # National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio. **WHAT CAN NUCLEAR ENERGY DO FOR SOCIETY?**

Frank E. Rom. Nov. 1971. 24 p. refs. Presented at the 2nd Uranium Plasma Symp., Atlanta, 15-17 Nov. 1971; Sponsored by Am. Inst. of Aeron. and Astronautics (NASA-TM-X-67963; E-6674) Avail: NTIS CSCL 05K

The utilization of nuclear energy and the predicted impact of future uses of nuclear energy are discussed. Areas of application in electric power production and transportation methods are described. It is concluded that the need for many forms of nuclear energy will become critical as the requirements for power to supply an increasing population are met. P.N.F.

see also: Astronautics & Aeronautics, Jan. 1972, p. 56-61.

A71-17694 * # Status of the nuclear powered airplane. Frank E. Rom (NASA, Lewis Research Center, Cleveland, Ohio). *Journal of Aircraft*, vol. 8, Jan. 1971, p. 26-33. 6 refs.

NASA has been carrying out a low-level effort to determine and solve the problems facing practical, safe and economical nuclear aircraft. The key problem is safety. The prevention of fission product release after a major accident on land is difficult. Studies indicate in principle that fission products can be contained; however, much work needs to be done to demonstrate the proposed techniques. Over-water flight minimizes the safety problem. This suggests the possibility of restricting early nuclear aircraft for over-water flights to gain experience and confidence. The use of thermal reactors appears to simplify the problem of containment because they make possible the avoidance of nuclear excursions in accidents by minimizing the fuel inventory. Low fuel inventory and the desirability of long reactor life requires reactor fuel with very high burnup capability. A fuel concept exists that has promise for meeting this requirement. Nuclear aircraft must weigh more than one million pounds in order that payloads of 15% of the gross weight or greater can be carried. (Author)

N71-25783* # National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
NUCLEAR POWERED AIR CUSHION VEHICLES FOR TRANSOCEANIC COMMERCE
 Frank E. Rom and Charles C. Masser Washington May 1971 52 p refs
 (NASA-TM-X-2293; E-6152) Avail: NTIS CSCL 21F

Large air-cushion vehicles (ACVs) greater than 3620 metric tons (4000 tons) gross weight, have the potential for hauling transoceanic cargo at rates in the range of \$0.006 to \$0.012 per metric ton-kilometer (\$0.010 to \$0.020/ton-n mi) at speeds of 185 kilometers per hour (100 knots). It theoretically would take a fleet of over 1000 10,000-metric-ton-gross-weight ACVs to handle 10 percent of the world transoceanic trade projected for 1985. ACVs using compact lightweight nuclear reactors show clearly superior performance for ranges of 3710 kilometers (2000 n mi) or greater. For a range of 7420 kilometers (4000 n mi) the total operating cost for chemical ACVs is three times that for nuclear ACVs. The nuclear ACV performance is less sensitive than the chemical ACV to the operating and cost assumptions used. Relatively large variations in any of the important assumptions had a relatively small effect on nuclear ACV performance.

Author

N72-19014* # National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
AIR CUSHION VEHICLES: A BRIEFING
 John L. Anderson and Patrick M. Finnegan Oct. 1971 56 p refs
 (NASA-CR-125686) Avail: NTIS CSCL 01B

Experience and characteristics: the powering, uses, and implications of large air cushion vehicles (ACV); and the conceptual design and operation of a nuclear powered ACV freighter and supporting facilities are described.

155

N71-38277* # National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
LARGE NUCLEAR-POWERED SUBSONIC AIRCRAFT FOR TRANSOCEANIC COMMERCE
 Frank E. Rom and Charles C. Masser Washington Nov. 1971 47 p refs
 (NASA-TM-X-2386; E-6271) Avail: NTIS CSCL 21F

Large subsonic aircraft, greater than 905 metric tons (1000 tons) gross weight, have the potential for hauling transoceanic cargo at rates in the range of \$0.006 to \$0.036 per metric ton-kilometer (\$0.01 to \$0.06/ton-n mi) at speeds of 740 to 925 kilometers per hour (400 to 500 knots). It theoretically would take a fleet of 500 such aircraft to handle 1 percent of the forecast world ocean trade in 1980. For gross weights of 3620 metric tons (4000 tons) the cargo rate would be reduced to less than \$0.012 per metric ton-kilometer (\$0.02/ton mi). It theoretically would take a fleet of over 1000 such aircraft to carry 8 percent of the world transoceanic trade projected for 1980 or 4 percent of the projected trade in 1995. Aircraft with a gross weight of 3620 metric tons (4000 tons) using compact lightweight nuclear reactors show better performance than chemical aircraft for ranges greater than 5565 kilometers (3000 n mi). Nuclear aircraft performance is less sensitive than that of chemical aircraft to the operating and cost assumptions used. Relatively large variations in any of the important assumptions have a relatively small effect on nuclear aircraft performance.

Author

N71-38423* # National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
A NUCLEAR POWERED AIR CUSHION FREIGHTER FOR THE 1980'S
 J. L. Anderson 1971 32 p refs Presented at the Am. Nud. Soc. Winter Meeting, Miami Beach, Fla., 17-21 Oct. 1971 (NASA-TM-X-67876; E-6434) Avail: NTIS CSCL 13J

A design for a transoceanic, dry cargo-carrying freighter is suggested; its use and operation in port are discussed. With a gross weight of 4500 metric tons (5000 tons), more than 50 percent of which is cargo, it will cruise at 50 meters per second (100 knots) in waves 2.4 meters (8 ft) high. Its peripheral jet-flexible skirt air cushion concept and air thrusters will let the freighter go over waves 8 meters high at reduced velocity. Power comes from a 1280 megawatt, helium-cooled thermal reactor. It could dock at any major port in the world, but because it needs no surface contact, it could also travel inland to land-locked ports. A modular terminal design and methods of cargo transfer are suggested. The concept of cargo containerization influences both the freighter and terminal design.

Author

1971

A70-43188 # Reactor for nuclear extended range aircraft. F. D. Orazio, Sr. (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio) and J. E. Werle (Westinghouse Astronuclear Laboratory, Pittsburgh, Pa.). In: American Nuclear Society, National Topical Meeting on Aerospace Nuclear Applications, Huntsville, Ala., April 28-30, 1970, Proceedings. (A70-43177 22-22) Meeting co-sponsored by NASA, the Southern Interstate Nuclear Board, and the Alabama Development Office. Huntsville, Ala., American Nuclear Society, 1970, p. 242-273.

There is a need for large military aircraft having the capability of extremely long flight endurance and range. Such aircraft could be used for surveillance type missions, or for an airborne command center to provide the country with a flexible, alert, mobile system capable of surviving a surprise nuclear attack. Because the payload, and therefore, the cost effectiveness, of a nuclear-powered aircraft increases with the overall size and weight of the airframe, the recent development of very large jet aircraft has made nuclear power economically attractive. The technological advancements of nuclear reactors for airborne purposes are discussed, along with the highlights of preliminary aircraft designs incorporating a high temperature, liquid metal cooled reactor. Concluding remarks include a discussion of some of the most critical problem areas that must be solved for the successful development of a nuclear-powered, long endurance, long range aircraft. (Author)

A71-22779 # Nuclear power for surface effect vehicle and aircraft propulsion. Frank E. Rom (NASA, Lewis Research Center, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics, Annual Meeting, 7th, Houston, Tex., Oct. 19-22, 1970, Paper 70-1221, 22 p. 8 refs.*

Preliminary results of an economic study that indicates the potential application of nuclear surface effect vehicles and aircraft for carrying transoceanic commerce in the post 1980 time period are presented. A summary of recent encouraging mobile nuclear reactor safety experiments for high speed impacts is also presented. The results of the economic study indicate that there would be a potential need for about 1500 nuclear surface effect vehicles of 10,000 tons gross weight with a speed of 100 knots to handle transoceanic commerce if the shipping cost would be about 1 to 2 cents per ton mile. The study indicates that nuclear powered surface effect vehicles may have the ability to carry cargo at rates less than 2 cents per ton mile. Subsonic nuclear aircraft with a gross weight of 1000 tons may be able to carry cargo at the rate of 4 to 5 cents per ton mile. Very large subsonic nuclear aircraft of the order of 10,000 tons in gross weight may be able to carry cargo at rates less than 2 cents per ton mile. It would take a fleet of 500 such aircraft to handle transoceanic trade that would be economically feasible to carry at 1 to 2 cents per ton mile in 1980. (Author)

N72-12604* # National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

AIRBREATHING NUCLEAR PROPULSION: A NEW LOOK
Frank E. Rom. Washington Dec. 1971 26 p refs
(NASA-TM-X-2425; E-6316) Avail: NTIS CSCL 21F

Nuclear-powered air-cushion vehicles using lightweight aircraft-type nuclear powerplants show promise of carrying transoceanic cargo at cost-per-metric-ton-kilometer (cost-per-ton-n mi) rates comparable to railroad rates. These rates are independent of the distance traveled. Cargo rates for nonstop distances of 4000 n mi are expected to be less than one-half those for similar fossil-fueled air-cushion vehicles. For 6000-n mi nonstop distances, the rates are expected to be less than one-sixth as much. There are no fundamental technical reasons why subsonic nuclear aircraft cannot be made to fly successfully if the gross weight is over 1 million lb. Public safety of airborne nuclear powerplants is receiving the greatest attention in low-level experimental and analytical investigations. Idealized model containment vessels which have been impacted on reinforced concrete showed no leaks after impact at velocities to 400 mph. The experiments indicate feasibility of impacting at speeds over 600 mph with no leaks. Author

N71-25411* # National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

PRELIMINARY IMPACT SPEED AND ANGLE CRITERIA FOR DESIGN OF A NUCLEAR AIRPLANE FISSION PRODUCT CONTAINMENT VESSEL

Patrick M. Finnegan, Richard L. Puthoff, and James W. Turnbow (Dyn. Sci. Corp., Phoenix, Ariz.) Washington May 1971 37 p
(NASA-TM-X-2245; E-6025) Avail: NTIS CSCL 21F

Reports and photographs of 96 major accidents occurring before 1965 and involving multiengine jet aircraft were studied. Impact speed and angle are presented for landing and takeoff accidents, cruise accidents without in-flight structural failure, and in-flight structural failure accidents. The landing and takeoff accidents had an average impact velocity of 200 ft/sec from any direction and a maximum impact velocity of 300 ft/sec with a 10 deg solid angle about the roll axis. The cruise accident without structural failure had an average impact velocity of 400 ft/sec and a maximum possibly as high as 1000 ft/sec (305 m/sec), both within a 10 deg solid angle about the roll axis. The in-flight structural failure accident had an average impact velocity of 400 ft/sec (122 m/sec) from any direction and a maximum possibly as high as 1000 ft/sec (305 m/sec) within a 10 deg solid angle about the roll axis. The in-flight structural failure accident determines the most severe impact speed for all impact angles. Author

70N21711♦♦ ISSUE 9 PAGE 1741 CATEGORY 32 NASA-TN-D-5730 E-4991
 126-15 70/03/00 36 PAGES UNCLASSIFIED DOCUMENT
 PARAMETRIC STUDY OF A FRANGIBLE-TUBE ENERGY- ABSORPTION SYSTEM FOR
 PROTECTION OF A NUCLEAR AIRCRAFT REACTOR
 (ANALYSIS OF FRANGIBLE-TUBE ENERGY ABSORPTION SYSTEM FOR PROTECTION
 OF NUCLEAR AIRCRAFT REACTOR)
 A/GUMTO, K. H.; B/PUTHOFF, R. L.
 NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. LEWIS RESEARCH CENTER,
 CLEVELAND, OHIO. AVAIL.NTIS
 WASHINGTON

♦ENERGY ABSORPTION/♦IMPACT DAMAGE/♦NUCLEAR PROPELLED
 AIRCRAFT/♦REACTOR SAFETY/ DECELERATION/ IMPACT ACCELERATION/ PIPES
 (TUBES)/ PLASTIC DEFORMATION/ SYSTEMS ANALYSIS/ WEIGHT ANALYSIS

70N23226♦♦ ISSUE 10 PAGE 1893 CATEGORY 22 NASA-TM-X-52765 E-5571
 69/00/00 21 PAGES UNCLASSIFIED DOCUMENT
 NEUTRONIC DESIGN OF A REACTOR CORE CONTAINING HEAT PIPES FOR
 APPLICATION TO A NUCLEAR AIRPLANE
 (NEUTRONIC DESIGN OF REACTOR CORE CONTAINING HEAT PIPES FOR
 APPLICATION TO NUCLEAR AIRPLANE)
 A/PUTHOFF, R. L.
 NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. LEWIS RESEARCH CENTER,
 CLEVELAND, OHIO. AVAIL..TIS

♦HEAT PIPES/♦NUCLEAR PROPELLED AIRCRAFT/♦REACTOR CORE/ NUCLEAR
 FUELS/ NUCLEAR PROPULSION/ NUCLEAR REACTORS/ REACTOR DESIGN

N69-36757*# National Aeronautics and Space Administration.
 Lewis Research Center, Cleveland, Ohio.
 PARAMETRIC STUDY OF LARGE NUCLEAR SURFACE
 EFFECTS MACHINES also A69-35780#
 Albert F. Kascak Washington NASA Sep 1969 41 p refs
 (NASA-TM-X-1888; E-4919) Avail: CFSTI CSCL 18K

Some performance estimates of a high speed peripheral
 jet nuclear powered surface effects machine are described. The
 calculations incorporate a recently proposed nuclear airplane reactor
 concept; this high temperature reactor reduces shield weight and
 eliminates a need for a heavy preheater. Payload fraction and
 reactor power are calculated for vehicle gross weights from 1000 to
 5000 tons, forward velocities from 0 to 250 knots, and clearance
 heights from 10 to 50 ft. For these ranges, the payload varied from
 0 to 60 percent of the gross weight, and the total reactor power
 varied from 400 to 10,000 NW.

N69-40060*# National Aeronautics and Space Administration.
 Lewis Research Center, Cleveland, Ohio.

A STEAM CYCLE FOR AIRCRAFT NUCLEAR PROPULSION
 Lawrence H. Fishback Washington Oct 1969 21 p refs
 (NASA-TM-X-1907) Avail: CFSTI CSCL 18E

A preliminary cycle analysis of a steam-driven, nuclear-powered
 turbofan engine is presented. It is found that maximum efficiency
 and minimum thrust per unit airflow both occur for a bypass ratio
 of zero. (This corresponds to minimum heat-exchanger-outlet air
 temperature.) Parametric numerical results are presented which can
 be used for selecting the proper engine operating conditions for
 a given airplane.

Author

A STUDY OF HEAT PIPE APPLICATIONS IN NUCLEAR AIRCRAFT PROPULSION SYSTEMS FINAL REPORT

(HEAT PIPES FOR NUCLEAR AIRCRAFT PROPULSION SYSTEMS)

A/SILVERSTEIN, C. C.

SILVERSTEIN (CALVIN C.), BALTIMORE, MD. AVAIL.NTIS

/♦HEAT PIPES/♦HEAT TRANSMISSION/♦NUCLEAR PROPELLED AIRCRAFT/♦NUCLEAR PROPULSION/ HEAT EXCHANGERS/ HEAT TRANSFER/ SYSTEMS ENGINEERING

N69-35723# National Aeronautics and Space Administration.

Lewis Research Center, Cleveland, Ohio.

THE POTENTIAL OF NUCLEAR POWER FOR HIGH-SPEED

OCEAN-GOING AIR-CUSHION VEHICLES

Frank E. Rom and Albert F. Kascak Washington Sep 1969

34 p refs

(NASA-TM-X-1871) Avail: CFSTI CSCL 21F

The use of nuclear powerplants based on nuclear aircraft technology to power ocean-going air-cushion vehicles has been investigated. Because aircraft nuclear powerplants might be an order of magnitude lighter than current nuclear marine plants, the performance of nuclear air-cushion vehicles is dramatically altered. Instead of vehicles limited to short ranges and speeds of about 80 knots, they become vehicles with virtually unlimited range and speeds in the range of 100 to 200 knots. The study considers vehicles with gross weights of 1000 to 10,000 tons and clearance heights from 10 to 40 feet, which are sufficient to clear ocean waves 80 to over 90 percent of the time. The cargo capacity ranges from 20 to 50 percent of the gross weight. Direct operating costs are 2 to 5 cents per ton-mile and are independent of the distance travelled.

Author

A68-22429 #

WILL THE NUCLEAR-POWERED AIRCRAFT BE SAFE?

Frank E. Rom (NASA, Lewis Research Center, Advanced Nuclear Propulsion Concepts Branch, Cleveland, Ohio) and Patrick M. Finnegan (NASA, Lewis Research Center, Nuclear Systems Section, Cleveland, Ohio).

Astronautics and Aeronautics, vol. 6, Mar. 1968, p. 32-40. 5 refs. Safety study showing that normal operations of a nuclear-powered aircraft can be made safe by designing unit shielding to protect the flight crew, passengers, cargo, and ground crew. The problem of refractory-metal vessels can be avoided by designing for preventing earth contact - i.e., by surrounding the vessel by suitable shock-absorbing frame. A system using frangible tubes can be envisioned as a cage surrounding and supporting the containment vessel while maintaining a specified minimum clearance from the ground. Concerning the question of excursions on impact, for thermal reactors, nuclear excursions can be excluded by prior removal of the moderator material. In the case of fast reactors, the core should be designed to avoid criticality when it collapses. Another possibility is to prevent core collapse that might come from impact loading. Flight procedures can be arranged so that the reactor-and-shield assembly is automatically placed in a normal shutdown mode of operation and switched to chemical power when appropriate.

V.P.

A68-22428 #

NUCLEAR PROPULSION FOR AIRCRAFT.

John M. Wild (General Dynamics Corp., Convair Div., San Diego, Calif.).

Astronautics and Aeronautics, vol. 6, Mar. 1968, p. 24-30. Survey of the current status of nuclear technology as it applies to aircraft propulsion, in terms of three independent studies. The basic premises of these studies were that only current technology was to be used for aircraft, power plant, and reactor system, that the design would concern a subsonic air transport with no maximum weight or cruise-altitude constraints, that the radiation dosages of crew, passengers, and ground personnel were not to exceed AEC limits for full-time radiation workers, that no fission-product release to the atmosphere would occur either in normal operation or in the event of reactor malfunction, and that reasonable fission-product containment would be provided for in the event of aircraft accident. No restrictions were placed on operation, ground-handling, maintenance, or repair, except for items within the radiation shield. Take-off, climb and acceleration assist, loiter, and landing were to be chemically powered. The studies indicate the feasibility of a 1-million-lb aircraft cruising at M = 7 to 8 at an altitude of 36,000 ft and capable of carrying a payload of ~300,000 lb.

V.P.

A68-24491 #

THE NUCLEAR-POWERED AIRCRAFT AS AN AIRBORNE LABORATORY.

Stuart William Greenwood (Manitoba, University, Mechanical Engineering Dept., Winnipeg, Manitoba, Canada).

Astronautics and Aeronautics, vol. 6, July 1968, p. 40. 44. 5 refs. Discussion of the use of nuclear-powered aircraft for the continuous observation of fixed distant points in space and continuous investigation of the atmosphere with the sun at a fixed position in the sky. Flight paths conducive to this type of study are derived, with emphasis on 60° latitude flight paths. The Lockheed C-5A Galaxy and the Boeing 747 are mentioned as candidates for such flights, if and when they become nuclear-powered.

R.B.S.

New Technology, Availability of C-5A spur second look at ANP.

Aerospace Technology, Feb. 26, 1968, p 26-27.

72N73353# TID-21987 X-381 AT(11-1)-171 68/10/23 81 PAGES
UNCLASSIFIED DOCUMENT
FEASIBILITY STUDY OF NUCLEAR-POWERED FLYING CRANE HELICOPTERS
A/SULLIVAN, R. J.
HUGHES TOOL CO., CULVER CITY, CALIF. (AIRCRAFT DIV.)
/♦FEASIBILITY/♦HELICOPTERS/♦NUCLEAR PROPELLED AIRCRAFT/ DIRECT POWER
GENERATORS/ TURBINE ENGINES

73N70612# NASA-TM-X-1626 E-3914 68/08/00 63 PAGES UNCLASSIFIED
DOCUMENT
SUBSONIC NUCLEAR AIRCRAFT STUDY
A/ROM, F. E.
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. LEWIS RESEARCH CENTER,
CLEVELAND, OHIO. AVAIL.NTIS
WASHINGTON
/♦AIRCRAFT SAFETY/♦FLIGHT SAFETY/♦NUCLEAR PROPELLED
AIRCRAFT/♦REACTOR SAFETY/♦SUBSONIC AIRCRAFT/ LIFE (DURABILITY)/ NUCLEAR
PROPULSION/ RANGE (EXTREMES)/ SYSTEMS ENGINEERING

69N14092# ISSUE 4 PAGE 595 CATEGORY 2 NASA-TM-X-52524
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68/00/00 34 PAGES UNCLASSIFIED DOCUMENT
NUCLEAR POWERED VTOL AIRCRAFT
(PERFORMANCE CHARACTERISTICS OF NUCLEAR POWERED VTOL AIRCRAFT)
A/FISHBACH, L. H.; B/STRACK, W. C.
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. LEWIS RESEARCH CENTER,
CLEVELAND, OHIO. AVAIL.NTIS
WASHINGTON
/♦AIRCRAFT PERFORMANCE/♦NUCLEAR PROPELLED AIRCRAFT/♦SYSTEMS
ENGINEERING/♦VERTICAL TAKEOFF AIRCRAFT/ BRAYTON CYCLE/ CONDENSERS
(LIQUIFIERS)/ FAN IN WING AIRCRAFT/ HELIUM/ LIQUID METAL COOLED
REACTORS/ RANKINE CYCLE/ WEIGHT (MASS)

A68-11739

NUCLEAR PROPULSION APPLICATIONS.

John S. Martinez and Richard K. Plebuch (TRW Systems Group, Redondo Beach, Calif.).
American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 4th, Anaheim, Calif., Oct. 23-27, 1967.
Paper 67-781. 11 p. 12 refs.
Members, \$1.00; nonmembers, \$1.50.

Survey of current and projected performance of a variety of nuclear propulsion systems. The missions for which they are most applicable are discussed, and the relative capabilities of each of the nuclear systems to perform these missions are compared to other types of propulsion. The nuclear propulsion systems discussed include nuclear aircraft, ramjets, solid core nuclear rockets, combined high thrust nuclear rocket/low thrust electric propulsion systems, gas core nuclear rockets, and radioisotope propulsion systems. Areas where insufficient data are available to accurately evaluate system performance are indicated, and some of the missions for which nuclear systems appear most attractive are identified. (Author)

A68-16809

A NUCLEAR SPACE PLANE.

Steven P. D. Smith and Glen J. Schoessow.
IN: SATURN V/APOLLO AND BEYOND; NATIONAL SYMPOSIUM, HUNTSVILLE, ALA., JUNE 11-14, 1967. TRANSACTIONS. VOLUME 2. [A68-16783 05-30]
Symposium sponsored by the American Astronautical Society, the University of Alabama, NASA, and the U.S. Army.
Edited by S. S. Hu.
Torrance, Calif., American Astronautical Society, 1967. 24 p.

Investigation of the capabilities of a new advanced propulsion concept, the nuclear space plane (NSP) in meeting the need for maneuverable vehicles that can operate in both the atmosphere and space regions. It is found that the addition of liquefaction apparatus to the nuclear-reactor propulsion cycle results in extended flight and maneuvering capability. One nuclear core can be optimized for nuclear control and thrust to perform well in the various atmospheres which exist on the planets considered. The NSP concept is concluded to be feasible, and it is reasonable to expect that present technical hardware will be able to function as components of NSP flight systems. M.F.

M68-11143 United Kingdom Atomic Energy Authority. Risley (England) Reactor Group
MARINE NUCLEAR REACTORS
S. Rigg and J. Kay 1967 35 p Presented at the Branch Meeting of the Inst of Mech. Engrs, Barrow, England, 1 Dec. 1966 (TRG-1500IR) HMSO 4s 6d

This report reviews the current state of progress made internationally in the development of nuclear power for marine propulsion units, stressing the economic factors influencing this development and outlining the technical factors involved. A typical pressurized water reactor incorporating a burnable-poison core and integral heat exchanger suitable for marine use is described and the main parameters for a 71 MW(H) reactor are listed. The main features and philosophy of the design, and development potential are then discussed. The effects of the particular requirements for the use of nuclear propulsion units on the design of the ship and its machinery, and economic comparisons with conventional methods of propulsion for various marine applications are also considered.

Author

COMMENTS ON NUCLEAR-POWERED SURFACE EFFECT SHIP DESIGN PROBLEMS. Petroff, Alex N. (Univ. of Michigan, Ann Arbor). J. Aircraft, 3: 78 (Jan.-Feb. 1966).

Some comparisons are made of the specifications and operating characteristics of lighter than air vehicles (such as a He-filled airship) and surface effect ships with respect to nuclear-powered propulsion. Pertinent characteristics and performance are given for a proposed He-filled airship to carry 200 passengers a distance of 3500 miles. A measure of efficiency with respect to the load carrying capacity, aerodynamics, and propulsion is given. In the light of recent improvements in structural materials and turbofan engines and with application of boundary-layer control, the case of the airship becomes even more promising than indicated by this data. If nuclear power is contemplated, considering the length of an airship of ~1000 ft, the weight of shielding material could be considerably reduced in comparison with shorter machines. This implies that large rigid airships as a means of economic mass transportation at speeds of 100 mph or higher warrant careful consideration and future studies. (BBB)

THE NUCLEAR AIRSHIP. Morse, Francis (Univ. of Houston). New Sci., 30: 12-14 (Apr. 7, 1966).

A feasible and economic nuclear airship, comprising a nuclear reactor coupled with a large lighter-than-air frame, is proposed. Weight and radiation-safety considerations of hypothetical nuclear airplanes and nuclear airships are compared. The displacement of the proposed nuclear airship is nearly twice that of previous conventional airships. The design speed is 103 mph for 6000 hp. The reactor is ceramic-fueled, lithium-cooled, shielded by a laminate of boron-treated polyethylene and lead, and contained in a pressurized steel sphere. Three engines are provided, the two smaller capable of operating on chemical fuel in case of reactor shutdown. The structural arrangement of the design is shown. A comparison of the characteristics of the proposed nuclear airship and the Hindenburg is given. The advantages of the use of the nuclear airship as an air freighter, especially for low-density freight, and as a luxury 400-passenger carrier are described. (M.J.T.)

CM-119,264, v.1 & v.2 1965
BIBLIOGRAPHY OF CONNECTICUT ADVANCED NUCLEAR ENGINEERING LABORATORY REPORTS. Dec.1965. 592p.

P Pratt & Whitney Aircraft
Contract AF (30-1)-2789

FMAC 500

440

TL 787. A6
v.2

N65-19525# Atomic Energy Information Service, Frankfurt
Am Main (West Germany).
AED INFORMATION SERVICE. SERIES C: BIBLIOG-
RAPHIES. SECTION 22: NUCLEAR SHIP PROPULSION.
J. N. Pstro. comp. Dec. 1964 51 p refs in GERMAN and
ENGLISH /15 RCN-Mededeeling No. 13
(AEC-C-22-03)

The task of supplying scientific and technical information
to scientists and engineers in the nuclear energy field, who
are assigned to the Atomic Energy Documentation Center in
the Federal Republic of Germany is explained. A bibliography
with author index is presented for nuclear ship propulsion.
E.E.B.

NASA TN D-1792
National Aeronautics and Space Administration.
STATIC LONGITUDINAL AERODYNAMIC CHARAC-
TERISTICS OF AN ELASTIC CANARD-FUSELAGE
CONFIGURATION AS MEASURED IN AIR AND IN
FREON-12 AT MACH NUMBERS UP TO 0.92.

E. Carson Yates, Jr., and Maynard C. Sandford.
July 1963. 18p. OTS price, \$3.00.
(NASA TECHNICAL NOTE D-1792)

A geometrically, dynamically, and elastically scaled
model of the clipped-delta canard and forward fuselage
of a projected nuclear-powered airplane has been
investigated by means of force tests conducted in the
Langley transonic dynamics tunnel. The statically
balanced canard was tested in both restrained and
free-floating conditions at several levels of dynamic
pressure.

74N71038 UCRL-6941 W-7405-ENG-48 62/06/03 320 PAGES
UNCLASSIFIED DOCUMENT
THE PLUTO PROGRAM

CALIFORNIA UNIV., LIVERMORE. LAWRENCE RADIATION LAB. AVAIL. NTIS
PRESENTED AT THE JOINT ARS/ANS/IAS NUCL. PROPULSION CONF.,
MONTEREY, CALIF., 15-17 AUG. 1962
/♦NUCLEAR PROPULSION/♦PLUTO REACTORS/ NUCLEAR PROPELLED AIRCRAFT/
URANIUM OXIDES

74N72638 APEX-901 AF33(600)-38062 AT (11-1)-171 62/06/28 305
PAGES UNCLASSIFIED DOCUMENT
PROGRAM SUMMARY AND REFERENCES: DIRECT AIR CYCLE AIRCRAFT NUCLEAR
PROPULSION PROGRAM
A/THORNTON, G.; B/ROTHSTEIN, A. J.; C/CULVER, D. H. C/ED.
GENERAL ELECTRIC CO., CINCINNATI, OHIO. (FLIGHT PROPULSION LAB.
DEPT.) AVAIL. NTIS
/♦NUCLEAR PROPELLED AIRCRAFT/♦REACTOR DESIGN/ AIRCRAFT DESIGN/
NUCLEAR PROPULSION/ REACTOR TECHNOLOGY

A65-21371 # -
NUCLEAR POWERED SURFACE EFFECT SHIPS DESIGN
PROBLEMS.
Rodolfo A. Montes de Oca and Harry M. Simpson (Boos-Allea
Applied Research, Inc., Bethesda, Md.).
American Institute of Aeronautics and Astronautics, General
Aviation Aircraft Design and Operations Meeting, Wichita, Kan.,
May 25-27, 1964, Paper 64-1861.
Journal of Aircraft, vol. 2, Mar.-Apr. 1965, p. 136-143. 9 refs.
Research sponsored by the Maritime Administration.
[For abstract see Accession no. A64-17896 12-04]

NACA RM E53D29
National Advisory Committee for Aeronautics.
AN ANALYSIS OF A NUCLEAR POWERED
SUPERCRITICAL-WATER CYCLE FOR AIRCRAFT
PROPULSION. Irving M. Karp. (Unclassified
printing authorized by NASA CLASSIFICATION
NOTICE, Issue Number 1, December 1, 1962.)
75p. OTS price, \$2.00. (NACA RM E53D29)

An analysis to indicate the feasibility of the super-
critical water compressor jet cycle for nuclear
powered aircraft is presented. Performance values
of the cycle are given for a range of design-point
engine operating conditions at a flight Mach number
of 1.5 and altitudes of 50,000, 40,000, and 30,000 feet,
and at a flight Mach number of 0.9 and an altitude of
40,000 feet. It is shown that the cycle is one requir-
ing low compressor pressure ratios and one develop-
ing low thrust per unit airflow; consequently, it
requires very high airflow rates and very large engine
and exchanger frontal areas.

74N72740 PWAC-363 AF 33(600)-40548 61/12/29 232 PAGES
 UNCLASSIFIED DOCUMENT
 HISTORY OF THE AIRCRAFT NUCLEAR PROPULSION PROGRAM AT PRATT AND
 WHITNEY AIRCRAFT; 13 JUNE 1947 TO 13 APRIL 1961
 R/GRAFFIN, W. D.
 PRATT AND WHITNEY AIRCRAFT; MIDDLETOWN, CONN. AVAIL. NTIS
 /♦NUCLEAR PROPELLED AIRCRAFT/♦REACTOR TECHNOLOGY/ BLOWERS/
 COMPRESSORS/ PERFORMANCE TESTS

71N72663♦ MACR-RM-E57F17 61/10/16 30 PAGES UNCLASSIFIED DOCUMENT
 PRELIMINARY ANALYSIS OF A NUCLEAR POWERED SUPERSONIC AIRPLANE USING
 RAMJET ENGINES
 R/COMOLLEY, D. J.; R/WEBER, R. J.
 NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. LEWIS RESEARCH CENTER;
 CLEVELAND; OHIO.
 WASHINGTON
 /♦NUCLEAR PROPELLED AIRCRAFT/♦NUCLEAR RAMJET ENGINES/♦SUPERSONIC
 AIRCRAFT/♦SYSTEMS ANALYSIS/ AIRCRAFT PERFORMANCE/ PERFORMANCE
 PREDICTION/ RADIATION SHIELDING

74N74168 APEX-611 AT(11-1)-171 AF 33(600)-38062 61/08/00 66 PAGES
 UNCLASSIFIED DOCUMENT
 NUCLEAR DESIGN OF FAST REACTORS FOR DIRECT CYCLE AIRCRAFT POWER
 PLANTS
 R/REID, R. E.; R/BRESLAUER, S. K.
 GENERAL ELECTRIC CO.; CINCINNATI; OHIO. (NUCLEAR MATERIALS AND
 PROPULSION OPERATIO

N-96556
 NUCLEAR ENGINE OPERATING CONSIDERATIONS.
 G. V. Newton, General Electric Co. (For
 presentation at SAE National Aeronautic
 meeting, New York, 1961). 4p.

Society of Automotive
 Engineers, Inc. Preprint
 338C

Discusses briefly mission characteristics,
 the airplane, the engine, flight operation,
 and nuclear engine maintenance.

N-88783
 THE POTENTIAL OF NUCLEAR-POWERED AIRCRAFT
 FOR COMMERCIAL CARGO TRANSPORT. J.P.
 Brady, Convair. (For presentation at SAE
 Nat. Aeronautic meeting, New York, Apr. 5-
 8, 1960). 5p. & illus.

Society of Automotive Engineers, Preprint
 Inc. 169B

N-88771
 FLIGHT RELIABILITY IN NUCLEAR AIRCRAFT.
 Lionel W. Credit, Martin Co. (For
 presentation at SAE national aeronautic
 meeting, New York, Apr. 5-8, 1960). 10p.,
 illus.

Society of Automotive Engineers, Preprint
 Inc. 169C

(PWAC-279) NUCLEAR JT4D-2 TURBOFAN POWER-PLANT CHARACTERISTICS SUMMARY. (Pratt and Whitney Aircraft, Middletown, Conn. (USA). Connecticut Advanced Nuclear Engineering Lab.). 6 Apr 1960. Contract AT(11-1)-229. 26p. Dep. NTIS \$3.50.

Declassified 20 Sep 1973.

Performance and weight data for a nuclear powerplant based on the use of a modified version of the JT4D-2 turbofan engine are presented. The powerplant is a lithium cooled nickel alloy reactor using intermediate heat exchangers, and with a secondary NaK coolant system to transfer heat to the engine radiators. (JVR)

(PWAC-274) PRATT AND WHITNEY AIRCRAFT NUCLEAR JT-11 TURBOJET POWERPLANT CHARACTERISTICS SUMMARY. Larson, J. (Pratt and Whitney Aircraft, Middletown, Conn. (USA). Connecticut Advanced Nuclear Engineering Lab.). 18 Mar 1959. Contract AT(11-1)-229. 45p. Dep. NTIS \$4.25.

Declassified 12 Sep 1973.

The power plant data and shielding information presented describe a nuclear power plant containing a lithium-cooled, solid-fuel-element type reactor coupled to six modified Pratt & Whitney Aircraft J-58 Mod. 1A turbojet engines. This power plant incorporates an intermediate heat exchanger with lithium as the fluid circulating in the primary loop and NaK as the fluid circulating in the secondary loop. The engines are fitted with burners and afterburners enabling the thrust produced by the nuclear power plant to be augmented by the use of chemical fuel. Weight data are tabulated for 350 MW and for 575 MW power plants. Flow schematics of the liquid metal system and of the bleed-air ducting are illustrated. Based on assumed conditions, shield information, including weights and direct dose pattern at 50 feet, is given for several reactor installations. Estimated performance of the 350 MW and of the 575 MW power plants is presented for nuclear heat only operation, and for nuclear heat plus interburning operation within an envelope of subsonic flight conditions. Performance on nuclear heat plus interburning and maximum afterburning is given for the 350 MW power plant up to a speed of Mach 3. Partial afterburning performance data at Mach 3 is shown for altitudes between 65,000 and 82,000 feet. (auth)

(PWAC-257) NUCLEAR RAMJET SUPERSONIC BOMBER POWERPLANT CHARACTERISTICS SUMMARY. Larson, J. (Pratt and Whitney Aircraft, Middletown, Conn. (USA). Connecticut Advanced Nuclear Engineering Lab.). 22 Aug 1956. Contract AT(11-1)-229. 66p. Dep. NTIS \$5.50. Declassified 20 Sep 1973.

An investigation of nuclear propulsion systems for supersonic manned bombardment aircraft has resulted in the conclusion that ramjet engines coupled to a lithium-cooled reactor might make flight speeds greater than Mach 3 attainable in an all-nuclear supersonic bomber. The power plant performance characteristics of two all-nuclear ramjet power plants estimated to be capable of propelling an airplane at the above speeds are presented. Each of these powerplants utilizes the heat generated in a 350 MW lithium-cooled solid fuel element type reactor with a 1750°F lithium temperature leaving the reactor. The first of these power plants presented incorporates an intermediate heat exchanger with lithium in the primary loop and NaK in the secondary loop and represents a power plant believed to be attainable in a reasonable time with normal development. The second of these nuclear power plants does not utilize an intermediate heat exchanger and the lithium is circulated directly to the radiators. This represents an advanced power plant because construction materials for the radiator that are both oxidation resistant and corrosion resistant to lithium are not foreseeable without a major advance in metallurgy. (auth)

(PWAC-275) ADVANCED NUCLEAR TURBOJET POWERPLANT CHARACTERISTICS SUMMARY FOR SUPERSONIC AIRCRAFT. Larson, J. (Pratt and Whitney Aircraft, Middletown, Conn. (USA). Connecticut Advanced Nuclear Engineering Lab.). 13 Mar 1959. Contract AT(11-1)-229. 27p. Dep. NTIS \$3.50.

Declassified 12 Sep 1973.

The estimated powerplant characteristics of an advanced nuclear powerplant intended for use in a nuclear supersonic manned airplane is contained in this report. This nuclear powerplant consists of a 575 MW, high temperature, lithium-cooled, solid fuel element type reactor coupled to six turbojet engines especially designed for a supersonic nuclear airplane. The lithium coolant passes from the reactor at 2000°F directly to the engine radiators without the use of an intermediate heat exchanger. The engines are fitted with burners enabling the thrust produced by the nuclear powerplant to be augmented by the use of chemical fuel for the take-off, transonic acceleration and landing portions of the flight. The powerplant components have been selected for a maximum thrust-to-weight ratio at Mach 3 and 55,000 feet altitude on nuclear heat only operation compromised for net thrust produced with chemical fuel augmentation during the transonic portion of flight. The powerplant data presented, therefore, are primarily applicable to an all supersonic mission on nuclear heat alone. Weight data are tabulated for the 575 MW powerplant. The engine envelope based on preliminary radiator size estimates is illustrated. A liquid metal system flow schematic and piping data are included. Shield information including reactor shield outline, assumptions, weights, and direct dose pattern at 50 feet is also included. Estimated performance on nuclear heat only operation and nuclear heat plus burning is presented for an envelope of flight conditions. (auth)

*CN-66914
NUCLEAR POWERED AIRCRAFT. J.F. Brady, Convaiv. (For presentation at SAE National Aeronautic meeting, Los Angeles, Sept. 29-Oct. 4, 1958). 8p. SAE

Society of Automotive Engineers, Preprint
Inc. 92A
Author

CN-80454
TOWARD THE ATOMIC AIRPLANE. (1960). 4p. diagrs.

NASA
Consultants Custom Translations,
Inc.
Muszaki Elet, no. 24, p. 13
Dec. 26, 1957

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1953

THE SOLID HYDROXIDE REACTOR: EFFECT OF REACTOR VARIABLES ON EFFICIENCY AND FUEL-BURNING TEMPERATURE REQUIREMENTS FOR SUPERSONIC AND SUPERSONIC AIRCRAFT NUCLEAR PROPULSION. Donald Rogers and Michael P. Volapiano. Feb. 10, 1953. 83p.

71N70226• NACA-RM-ES2D02 52/05/27 31 PAGES UNCLASSIFIED DOCUMENT
ANALYSIS OF A LIQUID-METAL TURBINE-PROPELLER CYCLE FOR PROPULSION OF
LOW-SPEED NUCLEAR-POWERED AIRCRAFT
A/RKM, F. E.; B/WACHTL, W. W.
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. LEWIS RESEARCH CENTER,
CLEVELAND, OHIO.
WASHINGTON
/♦LIQUID METALS/♦NUCLEAR PROPELLED AIRCRAFT/♦THERMODYNAMIC
CYCLES/♦TURBOGENERATORS/ TURBOJET ENGINES/ TURBOPROP AIRCRAFT

74N74147 NEPA-1723 51/04/05 42 PAGES UNCLASSIFIED DOCUMENT
PROJECTED CAPABILITIES OF NUCLEAR POWERED AIRPLANES. 1: APPLICATION
TO A HIGH ALTITUDE AIRPLANE (60,000 FEET)
A/CELNIKER, L.; B/CHURCHILL, J. R.
FAIRCHILD ENGINE AND AIRPLANE CORP., OAK RIDGE, TENN. (NEPA Div.)
AVAIL.NTIS
SPONSORED BY AEC
/♦AIRCRAFT DESIGN/♦NUCLEAR PROPELLED AIRCRAFT/ AIRCRAFT PERFORMANCE/
HIGH ALTITUDE

74N73118 NEPA-1725 51/04/05 39 PAGES UNCLASSIFIED DOCUMENT
PROJECTED CAPABILITIES OF NUCLEAR POWERED AIRPLANES. 3: APPLICATION
TO A SUPERSONIC AIRPLANE (MACH. NO. EQUALS 2.0)
A/CELNIKER, L.; B/CHURCHILL, J. R.
FAIRCHILD ENGINE AND AIRPLANE CORP., OAK RIDGE, TENN. AVAIL.NTIS
SPONSORED BY AEC
/♦ATTACK AIRCRAFT/♦NUCLEAR PROPELLED AIRCRAFT/♦PERFORMANCE
PREDICTION/♦SUPERSONIC AIRCRAFT/ AERODYNAMIC CONFIGURATIONS/ AIRCRAFT
DESIGN/ WEIGHT ANALYSIS

74N72787 NEPA-1726 51/04/05 49 PAGES UNCLASSIFIED DOCUMENT
PROJECTED CAPABILITIES OF NUCLEAR POWERED AIRPLANES. 4: APPLICATION
TO A SEA LEVEL AIRPLANE
A/BOYLES, R.
FAIRCHILD ENGINE AND AIRPLANE CORP., OAK RIDGE, TENN. (NEPA Div.)
AVAIL.NTIS
SPONSORED BY AEC
/♦NUCLEAR PROPELLED AIRCRAFT/♦REACTOR DESIGN/ AIRCRAFT DESIGN/
AIRCRAFT PERFORMANCE/ LOW ALTITUDE/ OPTIMIZATION

F. GEOTHERMAL

1974

ENVIRONMENTAL PLANNING FOR THE GEOTHERMAL LEASING PROGRAM ON PUBLIC LANDS.

R.T. Stone, T.O. Friz, and D.W. Carlson.

AIChE Symposium Ser., v.70, no.136, 1974, p.777--.

Enactment of the Geothermal Steam Act on December 24, 1970, authorized certain public lands to be leased by the Secretary of the Interior for development of geothermal steam and associated geothermal resources. An interdisciplinary task force was established to prepare an environmental statement as required by the National Environmental Policy Act of 1969 and to prepare and implement the regulations for leasing and operations.

Environmental evaluations will provide a basis for deciding whether a tract should be leased. Proponents of geothermal energy claim it is the answer to our future clean energy needs. Although certain potential geothermal areas may not be leased due to environmental considerations, application of advanced technology could result in the leasing of land otherwise closed to geothermal development. The outlook from an environmental standpoint is encouraging, provided geothermal resources can be developed economically.

1974

ENVIRONMENTAL ASPECTS OF THE MULTI-PURPOSE DEVELOPMENT OF GEOTHERMAL RESOURCES.

J.S. Wilson.

AIChE Symposium Ser., v.70, no.136, 1974, p.782--.

Solutions prepared to simulate low salinity geothermal brines of the Imperial Valley, California, were heated to 450°F. and flashed in a two-step mode. Carryover of boric acid, carbon dioxide, and hydrogen sulfide in the steam is studied. Oxidation of the hydrogen sulfide with oxygen prior to flashing is demonstrated as a feasible sulfide removal method. The residual brine contained large amounts of hydrous silica solids. Flocculation and settling rates of these solids are determined.

1974

POSSIBLE EFFECTS OF GEOTHERMAL WATER AND STEAM PRODUCTION ON THE SUBSURFACE ENVIRONMENT.

R.L. Whiting.

AIChE Symposium Ser., v.70, no.136, 1974, p.762--.

Production from geothermal systems may cause changes in some or all of the following subsurface conditions: temperature, pressure, hydrologic parameters, chemical characteristics, bulk chemistry, and seismicity. The effects of such changes are discussed and recommendations are made to permit proper exploitation of geothermal resources.

GEOTHERMAL BRINES - ENVIRONMENTAL EFFECTS OF THEIR FUTURE USE AS AN ENERGY SOURCE.

G.E. Coury.

AIChE Symposium Ser., v.70, no.136, 1974,

p.760--Future utilization of low temperature brines

will require the application of secondary fluid cycles to remove energy from the brine. These cycles involve a low-boiling liquid contained within a closed loop, that is vaporized by the hot brine, expanded through a turbine, condensed and recycled. The cooled brine is then returned to the reservoir for pressure maintenance.

A74-27321 Geothermal electricity production. G. R. Robson (United Nations, New York, N.Y.). Science, vol. 184, Apr. 19, 1974, p. 371-375. 11 refs.

An attempt is made to evaluate the economic, institutional and technological factors which will influence the production of geothermal electricity in the near future. Dry steam and hot water geothermal fields which may be available for electric power generation are assessed. Emphasis is on the U.S. prospects in the field.

1974

NONELECTRICAL USES OF GEOTHERMAL RESOURCES. Ogle, W. E. Geotherm. Energy Mag.: 2: No. 1, 32-33(Jan 1974).

Future energy demands in the United States indicate that by 1985 about 30% of the total energy use will be for non-electrical, non-transportation uses. This includes residential and commercial space heating, chemical processing, and other manufacturing processes. It appears that most of that 30% could be satisfied with geothermal energy. These same studies predict that about 35% of the U. S. energy consumption by 1985 will be used to produce electricity. These predictions indicate that the use of energy to supply electricity will increase out of proportion by 1985. By deductions, it is shown that geothermal energy could be used directly in place of electrical power. Every kilowatt furnished by geothermal heat could save 3 kW of some other form of energy. (MCW)

LAW NEEDED FOR GEOTHERMAL ENERGY. Fannin, P. Pub. Util. Fortn.: 93: No. 3, 15-17(31 Jan 1974).

The Geothermal Energy Act of 1973, S 2465, was incorporated into the comprehensive Energy Research and Development Policy Act, passing the Senate on Dec. 7, 1973. The bill provides a mobilization of both private and governmental efforts to utilize resources that are economically and commercially useful in meeting the energy needs. Key elements include a federal loan guaranty program, use of space and nuclear development agencies to further geothermal research, and a plan to develop resources on federal lands. (MCW)

GEOTHERMAL RESOURCES OF COLORADO. Pearl, R. H. (Colorado Geological Survey, Denver). Geotherm. Energy Mag.: 2: No. 1, 18-20(Jan 1974).

The U. S. Geological Survey lists Colorado as having no known geothermal resource areas. Several areas warrant investigation as possible geothermal areas. The San Luis Valley, a northern extension of the Rio Grande Rift Zone of New Mexico, is an area of anomalous heat flow values, 1.5 to 2.08 HF U. Around the western edge of this valley and extending into the Arkansas River Valley are numerous hot springs. (MCW)

1974

GEOTHERMAL COOLING URGED FOR MANAGUA. Geotherm. Energy Mag.: 2: No. 1, 51(Jan 1974).

Geothermal resources in Managua, Nicaragua could serve as a source of heat for the city as it does in Reykjavik, Iceland. Direct use of Earth heat sources for air conditioning by a single heat-to-cold conversion process for the new city of Managua would cost only one-half as much as electric power. Injection of water under the ground to replace hot water and steam used by the cooling system should make the source last forever. (MCW)

PRACTICAL APPLICATION OF GEOTHERMAL STEAM. Flanney, J. P. Pub. Util. Fortn.: 93: No. 3, 18-20(31 Jan 1974).

The Geysers power plant, 60 miles north of San Francisco, is the largest geothermal installation in the world and the only such system in the United States. Ten units are now in operation producing 396,000 kW, using steam piped directly from wells tapping a dry-steam reservoir. A description of the system is given. It appears that geothermal development in the USA will be confined to the West, and exploration must be accompanied by more research. The role of government and industry in geothermal development is explained. It is estimated that by the year 2000, 6 million kilowatts of geothermal energy might be in operation in the United States. (MCW)

LAWRENCE LIVERMORE LABORATORY. Geotherm. Energy Mag.: 2: No. 1, 26-31(Jan 1974).

The Livermore approach represents the first serious attempt to extract large-scale electrical energy from salty hot waters of a geothermal deposit. At the Geysers, relatively clean and dry naturally occurring steam is utilized. In New Zealand and Mexico, the steam component is separated from the brine and used to generate electricity. An effort will now be made to extract energy from the total brine mixture of steam, hot water, and salts from the Salton Sea Trough with the total flow method of geothermal energy generation. (MCW)

(LA-UR-73-1695) ARTIFICIAL GEOTHERMAL RESERVOIRS IN HOT VOLCANIC ROCK. Aamodt, R. L. (Los Alamos Scientific Lab., N. Mex. (USA)). 1974. 13p. (CONF-740209-1). Dep. NTIS \$3.00.

From U. S.-Japan cooperative science seminar on the utilization of volcano energy; Hilo, Hawaii, USA (4 Feb 1974).

Some recent results from the Los Alamos program in which hydraulic fracturing is used for the recovery of geothermal energy are discussed. The location is about 4 kilometers west and south of the ring fault of the enormous Jemez Caldera in the northcentral part of New Mexico. It is shown that geothermal energy may be extracted from hot rock that does not contain circulating hot water or steam and is relatively impermeable. A fluid is pumped at high pressure into an isolated section of a wellbore. If the well is cased the pipe in this pressurized region is perforated as it is in the petroleum industry, so that the pressure may be applied to the rock, cracking it. A second well is drilled a few hundred feet away from the first. Cold water is injected through the first pipe, circulates through the crack, and hot water returns to the surface through the second pipe. Results are described and circumstances are discussed under which artificial geothermal reservoirs might be created in the basaltic rock of Hawaii. (MCW)

DECISION STATEMENT OF SECRETARY OF INTERIOR ON GEOTHERMAL RESOURCES PROGRAM. Morton, R. C. B. Geotherm. Energy Mag.; 2: No. 2, 22-24 (Feb 1974). The Secretary of the Interior determined to open all available Federal lands to leasing under the Geothermal Steam Act of 1970 and to promulgate geothermal resources leasing, operations, and unit regulations. The lands of known geothermal resources in the Clear Lake-Geyers area, the Mono Lake-Long Valley area, and the Imperial Valley were offered for competitive leasing on January 22, 1974. The limitations are outlined. (MCW)

(ANCR-1139) FY 1974 PROGRAM PLAN FOR GEOTHERMAL PROJECT. (Aerjet Nuclear Co., Idaho Falls, Idaho (USA)). 5 Feb 1974. Contract AT(10-1)-1375. 76p. Dep. NTIS \$5.45.

The Program Plan specifies the basic plan for the utilization of FY-74 funds allocated by the AEC Division of Applied Technology and contributions from other participants for the development of geothermal energy in southern Idaho. Funding priorities are dictated by the Construction Data Package submission deadline and the October 1, 1974, site selection. Tasks not funded during FY-74 will be pursued during FY-75. (auth)

GREAT GREEN BOILER IN THE SKY. Russell, T. K. Geotherm. Energy Mag.; 2: No. 2, 35-48; 50-52 (Feb 1974).

The Department of the Interior forecasts that the U. S. energy supply and consumption to the end of the century including the primary conversion of energy forms to secondary forms such as electricity and synthetic gas is expected to grow at an average rate of 3.6 percent at the expense of using up the fuel supplies too fast. With all energy development technologies lagging, an examination was made of geothermal energy with Planet Earth's referred to as the great green boiler in the sky. Larderello's steam plants have been producing electricity since 1904. Development in other countries is reviewed and now the first contract has been established for Pacific Gas and Electric Company to begin building power plants at the Geysers. Eight units are installed and operating; during 1973, units 9 and 10, each with a net operating capacity of 53 Mw are expected to be installed and in operation. In 1973 an additional 106 Mw are expected; in 1975, another 106; in 1976, a unit of 110; and continuing development is planned. A description of the geothermal types is given. The technologies applied for the development of the Geysers and the accompanying power plants are discussed. (MCW)

Geothermal Energy. A Bibliography with Abstracts.

Axel C. Ringe.

National Technical Information Service, Springfield, Va. Apr

74. 45p NTIS-WIN-74-018

COM-74-10739/2WE PCS20.00/MF\$20.00

The bibliography contains 40 selected abstracts of research reports retrieved using the NTIS on-line search system--NTISearch. The report covers all aspects of geothermal energy including development, prospecting, technology, and corrosion problems.

GEOTHERMAL STEAM SUPPLIES AIDED POWER FOR MITSUBISHI'S AKITA ZINC PLANT. Rutledge, P. (Mc-

Graw-Hill World News, Tokyo). Eng. Mining J.; 176: No. 2, 78-79 (Feb 1974).

The Mitsubishi geothermal generating plant is the third geothermal station to be built in Japan, but the first to be used in nonferrous production. The three wells will be capable of generating 6,500 kW for power for the zinc plant in 1974. With the coming on-stream of an additional well, the output will provide one-fifth of the zinc plant's total electric power requirement. (MCW)

POWER FROM THE SALTON TROUGH.

D.E. Thomsen.

Science News, v.106, July 13,1974, p.28,29.

California's Imperial Valley contains a strategically located geothermal resource. A group from the Lawrence Livermore Lab. is working on ways to trap it.

GEOTHERMAL OPPORTUNITIES BEAR CLOSER LOOK.

T. Meidav.

Oil & Gas Jour., v.72, no.19, May 13,1974, p.102-106.

On Jan.22,1974, the U.S. Dept. of Interior conducted the first lease ever of federal lands for geothermal resource exploration and development. A total of \$6.8 billion has been spent in bids for 23,447 acres in three areas of California.

METHOD OF EXTRACTING HEAT FROM DRY GEOTHERMAL RESERVOIRS. Potter, R. M.; Robinson, E. S.; Smith, M. C. (to United States Atomic Energy Commission). US Patent 3,786,858. 22 Jan 1974. Filed Date 27 Mar 1972. 6p.

Hydraulic fracturing is used to interconnect two or more holes that penetrate a previously dry geothermal reservoir, and to produce within the reservoir a sufficiently large heat-transfer surface so that heat can be extracted from the reservoir at a usefully high rate by a fluid entering it through one hole and leaving it through another. Introduction of a fluid into the reservoir to remove heat from it and establishment of natural (unpumped) convective circulation through the reservoir to accomplish continuous heat removal are important and novel features of the method. (auth)

Idaho Geothermal R and D Project Report for Period December 16, 1973 to March 15, 1974.

J. P. Kunze, and L. G. Miller.

Aerofect Nuclear Co., Idaho Falls, Idaho. 18 Mar 74, 53p
ANCR-1155 PCS4.00/MFS1.45

The Idaho Geothermal R and D Project was initially chartered by the Division of Applied Technology in December 1973. This report covers the first three months of activity. A brief summary is given in Section 2, with more detailed discussions in subsequent sections. (Author)

IMPERIAL VALLEY INVESTIGATIONS: UTILIZATION OF THE SODIUM - POTASSIUM - CALCIUM GEOTHERMAL EXPLORATION TECHNIQUE IN THE IMPERIAL VALLEY AREA, CALIFORNIA. Coplen, T. B. (Univ. of California, Riverside). Geotherm. Energy Mag.; 2: No. 2, 32-34 (Feb 1974).

The technique of Fournier and Truesdell's function was used to determine Na, K, and Ca concentrations of nearly 200 well water, spring water, hot spring, and geothermal fluid samples from the Imperial Valley area. It is shown that under favorable conditions Na, K, and Ca concentrations in natural waters may be used to predict the last temperature of water-rock equilibration and that most geothermal fluids plot near a straight line on a graph of the function $F(T) = \log (Na/K) + \beta \log \sqrt{(Ca)/Na}$ versus reciprocal of the absolute temperature. The value for beta is $4/3$ unless equilibrated temperatures are above 100 C, in which case beta is $1/2$. Lower values for $F(T)$ indicate higher water-rock equilibration temperatures. $F(T)$ values for 50, 100, and 200 C are approximately 2.6, 2.0, and 1.1 respectively. The geothermometer is a useful tool for predicting subsurface temperatures and for distinguishing the existence of a geothermal system at depth. (NCW)

NEVADA GEOTHERMAL RESOURCES: Report describing the State's geothermal resources, and outlining exploratory efforts conducted to date. (Report 21, available at \$1 from Nevada Bureau of Mines and Geology, University of Nevada, Reno, 89507.)

THE HYDROGEN ECONOMY MIAMI ENERGY (THEME) CONFERENCE.
Presented by The School of Engineering &
Environmental Design, Univ. Miami, Coral
Gables, Florida.
Sponsored by The National Science Foundation,
Defense Advanced Research Projects Agency,
and The School of Continuing Studies, Univ.
of Miami.
Miami Beach, Florida, Mar.18-20,1974.

**GEOHERMAL ENERGY AS A PRIMARY SOURCE
IN THE HYDROGEN ENERGY ECONOMY**

F. Maslan, T. Gordon, The Futures Group, Glas-
tonburg, Connecticut, M. Carasso, L. Beaulaurier,
J. Gallagher, J. Hankin, Bactel Corporation, San
Francisco, California

TITLE: Proceedings: National Conference on
Geothermal Energy, Volumes 1 and 2

AUTHOR: Veysey, V.V. (Chairman)

CORPORATE AUTHOR: University of California,
Riverside

ADDRESS: Riverside, CA 92502

PUBLICATION DESCRIPTION: Entire proceedings, 717
p.

PUBLICATION DATE: 1973, August

SPONSOR: National Science Foundation, PANF Program

ABSTRACT: This is a two-volume presentation of
the statements and general conclusions of the
May 10-11, 1973 National Conference on
Geothermal Energy. It also contains the
papers that were prepared for consideration
by the conference participants. Central to
the conference's purpose was the examination
of the role of the state and regulatory
procedures affecting the area of geothermal
resource development. The conference was
divided into panel session meetings and
general sessions. Volume 1 contains the
major speeches and the panel groups'
conclusions. An appendix containing the
conference agenda and lists of participants
and attendees is included in Volume 1.
Volume 2 contains two background items
prepared for consideration at the conference,
"The Interrelationship Between Federal,
State, and Local Regulatory Agencies on the
Development of the Geothermal Resource in
California" and "Flow Chart of Critical Path
in Geothermal Explorations," and eight
documents pertaining to the statutory and
legal aspects of the geothermal resource and
its regulation. (DCH)

MODEL STUDIES OF GEOTHERMAL STREAM PRODUCTION.

C.V. Cady, et al.

AIChE Symposium Ser., v.69, no.129, 1973, p.445--.

A physical model of a geothermal steam reservoir was operated over a range of conditions from a compressed liquid to boiling liquid to single-phase steam reservoir. No significant vapor pressure lowering was observed in the unsolidated sand model. Existence of dry steam zones and two-phase boiling zones was observed.

POLLUTION CONTROL FOR GEOTHERMAL POWER PLANTS.

J.T. Kuwada.

AIChE Symposium Ser., v.70, no.136, 1974, p.772--.

Geothermal energy as manifested in geothermal steam or hot water is not inherently pollution free. There can be adverse environmental impacts in the development and utilization of geothermal energy for power generation. But it will be shown that the impact on the environment from geothermal energy is far less severe than from any conventional fuel in use today.

GEOTHERMAL POWER PLANT DESIGN.

J.T. Kuwada.

AIChE Symposium Ser., v.69, no.129, 1973, p.439--.

This paper discusses the engineering considerations involved in the design of electric power generating plants utilizing geothermal energy in the form of dry steam, wet (flashed) steam and hot water (binary fluid cycle).

THE GEYSERS GEOTHERMAL POWER PLANT.

J.P. Finney.

AIChE Symposium Ser., v.69, no.129, 1973, p.459--.

The earth's geothermal energy resources have been harnessed for the generation of electric power in several areas throughout the world. At the Geysers, 80 miles north of San Francisco, 6-steam turbine-generator units with a combined capacity of 184,000 kw comprise the only geothermal power plant in the United States. Additional units now under design and construction will increase this to 502,000 kw by the end of 1974.

GEOTHERMAL HEATS UP. Environ. Sci. Technol., 7: No. 8, 680-681 (Aug 1973).

The first successfully tapped sources of geothermal steam were put into use in Lardarello, Italy in 1904 and are still producing electricity today. The steam at Lardarello is clean and dry. In the United States, most geothermal steam is mineral-laden and confined to the West. Corrosion, solid-waste disposal, and transport of the steam to urban areas are factors to be considered. Some of the geothermal wells drilled in the Imperial Valley in California yield less than 20% steam, the rest being superheated brine. The salinity of this 80% hot water brine may be 20 to 30 times as high as that of seawater. The Geysers geothermal field in the mountains 90 miles north of San Francisco produces dry steam. Technology for using hot water geothermal sources is being devel-

N73-27369# Arizona Univ., Tucson. Office of Arid Lands Studies.

EXPLORATION AND EXPLOITATION OF GEOTHERMAL RESOURCES IN ARID AND SEMIARID LANDS: A LITERATURE REVIEW AND SELECTED BIBLIOGRAPHY Arid Lands Resource Information Paper No. 2 1973 125 p

(Contact DI-14-31-0001-3729)
(PB-218830/8. W73-07420: OWRR-W-144(2)) Avail: NTIS HC \$5.45 CSCL 08G

Contemporary techniques for exploration of geothermal resources are outlined, with particular emphasis on the western U.S. as typical of problems encountered in arid and semiarid lands. These include field reconnaissance, infrared aerial reconnaissance, photogeologic mapping, drilling, geochemical analysis of ground water, application of fluid dynamics to natural steam systems, electrical prospecting, seismic, gravity, and magnetic surveys. Environmental impacts, including noise, odors, subsidence, and legal problems involving development regulations, are reviewed.
(Author Modified Abstract)

GEOTHERMAL EXPLORATION ON PUBLIC LANDS: WHEN AND UNDER WHAT CONDITIONS. Bowen, R. G. Geotherm. Energy Mag.: 1: No. 1, 25-26(Aug 1973).

A bill authorizing the exploration and development of geothermal resources on public lands was signed in the early 1970's. No permits or leases have been granted, and the author feels there may have been a deliberate effort to keep geothermal development from competing with more-favored energy sources. White's estimation (30,000 MW) on which the administration based its assumptions, is not thought to be more valid than that of Rev(Hickel report) who estimated 395,000 megawatts from geothermal energy. It appears that geothermal regulations are at a standstill. (MCW)

FEDERAL TAX POLICY AND GEOTHERMAL ENERGY DEVELOPMENT. Finn, D. F. X. 1: No. 3, 39-42(Oct 1973).

The development of geothermal resources in the U. S. is impeded by the Federal tax policies that exist. The present state of tax rules governing utilization of geothermal energy, certain proposed changes in tax laws which would, if enacted, inhibit utilization of geothermal energy, and changes in present tax rules that would encourage utilization of geothermal energy are discussed. A statement by the accounting firm of Coopers and Lybrand is expanded. The accountants in the firm are the most knowledgeable in the U. S. on geothermal energy matters, representing firms that have established commercial geothermal production, selling the product, and developing additional markets. (MCW)

Geotherm. Energy Mag.

GEOTHERMAL ENERGY: POTENTIAL OF WASHINGTON STATE. Russell, R. H. Geotherm. Energy Mag.: 1: No. 4, 39-48(Dec 1973).

The State of Washington generally, the southern Cascades principally, and the Northern Cascades and Olympic Mountains, to a lesser degree, do possess geohydrologic parameters, thermal springs, and other surface and subsurface manifestations that suggest that the state may have the potential for a moderate to major geothermal energy resource. Geologic, hydrologic, and geophysical investigations and evaluations will be required, however, before reservoirs can be identified and defined and their energy potential estimated on a quantitative and qualitative basis. If environmental-impact problems can be resolved within acceptable limits, then an objective and viable investigation, evaluation, and test drilling program should be started. One area, North Bonneville, stands out as a preferred site for initial geothermal energy potential testing. (auth)

N74-16894# Committee on Science and Astronautics (U. S. House).

GEOTHERMAL ENERGY

Washington GPO 1973 390 p refs Hearings on HR. 8628 and H.R. 9658 before Comm. on Sci. and Astronaut., 93d Cong., 1st Sess., No. 21, 11, 13, and 18 Sep. 1973

Avail: Subcomm. on Energy

The hearings are reported concerning the economic and technological feasibility of developing geothermal energy sources. Two bills are presented and discussed which would establish a Geothermal Energy Development Corporation to construct two or more geothermal demonstration installations and to develop alternate technology for generating steam and electric power from geothermal sources. Other topics include: the state of geothermal energy technology; environmental problems; the status of R and D activities; and international and foreign K.M.M. considerations.

Plowshare Technology Assessment, Prospectives for Nuclear-Stimulated Geothermal Power in the Western U.S..

Gary M. Sandquist.

Western Interstate Nuclear Board, Lakewood, Colo. Feb 73, 115p NSF-RA-G-73-014

PB-231 011/8WN PCS4.50/MF\$1.45

The feasibility of using nuclear explosives to stimulate the output of geothermal sites is examined for the Western U.S. Actual explosives applications appear limited to marginal geothermal sites where explosive yield of 100 KT or less is adequate.

GEOTHERMAL ENERGY. Review of Research and Development. Armistead, H. C. H. (ed.). Paris; United Nations Educational, Scientific and Cultural Organization (1973). 196p. Unipub, Inc., New York, \$16.00.

Following a general review of what geothermal energy is, fourteen abstracts were prepared from papers on exploration, training, utilization, corrosion control, economics, and management of geothermal energy. (MCW)

BASIC THEORIES. Bellard, E. (Cambridge Univ. Eng.). pp 19-29 of *Geothermal Energy*. Armistead, H. C. H. (ed.). Paris; United Nations Educational, Scientific and Cultural Organization (1973).

A brief account is given of the structure of the Earth and of the processes going on within, particularly of the generation and transport of heat. New ideas have recently evolved and the views of the successful revolutionaries are adopted: those of the remnant defending the traditional position cannot be explained at every point. Topics studied include crust, mantle and core; underground temperatures and heat flow; the source of the heat; volcanoes, ridges and island arcs; the mechanism of plate motion; and the transfer of heat to the surface. (MCW)

ROLE OF GEOLOGY AND HYDROLOGY IN GEOTHERMAL EXPLORATION. McNitt, J. R. (United Nations, New York). pp 33-40 of *Geothermal Energy*. Armistead, H. C. H. (ed.). Paris; United Nations Educational, Scientific and Cultural Organization (1973).

The application of geology and hydrology to the exploration of geothermal resources is described. The bases on which geologic decisions are made through the successive phases of an exploration project are followed in sections entitled: selection of a region for reconnaissance; selection of prospect areas; selection of drill sites; and drilling and testing. (45 references) (MCW)

GEOPHYSICAL METHODS IN GEOTHERMAL EXPLORATION. Banwell, C. J. pp 41-48 of *Geothermal Energy*. Armistead, H. C. H. (ed.). Paris; United Nations Educational, Scientific and Cultural Organization (1973).

Geophysical prospecting is the art of detecting and interpreting anomalies in the local pattern of certain physical quantities, as measured by suitable sensing equipment and techniques. It must proceed in close coordination with geology, hydrology, and geochemistry, so that physical measurements may constantly be interpreted and checked. Preliminary evidence of a geothermal field; world distribution of hydrothermal systems, and the preliminary data required are discussed. Four stages of the exploration survey are described, and then the effects of exploitation on the surrounding area are discussed. (MCW)

GEOCHEMICAL METHODS IN GEOTHERMAL EXPLORATION. Sigvaldason, G. E. (Univ. of Iceland, Reykjavik). pp 49-59 of *Geothermal Energy*. Armistead, H. C. H. (ed.). Paris; United Nations Educational, Scientific and Cultural Organization (1973).

Geochemical methods are used in prospecting for potential geothermal exploitation, and chemical data on natural discharge from thermal areas serve as an important guide during subsurface exploration. As drilling proceeds, chemical analysis of deep thermal fluids provides information on flow patterns of water and assists in selecting improved drilling sites. During production, testing, and utilization, chemistry provides an efficient and inexpensive tool to detect minor and major changes in the reservoir with regard to temperature and water levels. Chemical analyses of waters and gases from various world areas where geothermal exploration is occurring are tabulated. (49 references) (MCW)

STRUCTURE AND BEHAVIOR OF GEOTHERMAL FIELDS. Faccia, G. pp 61-68 of *Geothermal Energy*. Armistead, H. C. H. (ed.). Paris; United Nations Educational, Scientific and Cultural Organization (1973).

Basic models of a geothermal steam field and low-temperature hot-water field are described from geological, geochemical, and geophysical exploration data. Then the Geysers geothermal field, California; the Otake geothermal field, Japan; and the Larderello geothermal field, Italy are classified to see how they generally conform to wet steam, dry steam, or hot water fields. (MCW)

DRILLING FOR GEOTHERMAL STEAM AND HOT WATER. Matsuo, K. (Geothermal Energy Association, Tokyo). pp 73-83 of *Geothermal Energy*. Armstead, H. C. H. (ed.). Paris; United Nations Educational, Scientific and Cultural Organization (1973).

A method using rotary drilling for geothermal steam and hot water is described. Drilling with mud is the most common method, but air drilling is faster and cheaper. Geothermal wells are generally drilled with standard rigs as used for crude oil and natural gas. Well surveys, well spacing, safety installations and precautions, and well repairs are discussed. (25 references) (MCW)

WELL MEASUREMENTS. Dench, N. D. (Ministry of Works, Wellington, N. Z.). pp 85-96 of *Geothermal Energy*. Armstead, H. C. H. (ed.). Paris; United Nations Educational, Scientific and Cultural Organization (1973).

Geothermal well fluid measurements are made for the basic study of a natural resource; assessment of an underground thermal reservoir for possible exploitation; assistance in drilling operations; appraisal of individual wells for production; mechanical engineering design requirements, including safety of equipment and personnel; legal requirements for ownership, safety, or waste disposal; fluid sales; and plant operation. Measurements include reservoir investigation of size, permeability and temperature, and fluid composition and pressure; well flow characteristics of temperatures and pressures and the corresponding flow rates of steam, hot water, and gas; downhole engineering data of casing condition, mineral deposition, or levels of permeability. (33 references) (MCW)

COLLECTION AND TRANSMISSION OF GEOTHERMAL FLUIDS. Smith, J. H. (Ministry of Works, Wellington, N. Z.). pp 97-106 of *Geothermal Energy*. Armstead, H. C. H. (ed.). Paris; United Nations Educational, Scientific and Cultural Organization (1973).

The collection and transmission of geothermal fluids may include hot water, steam, or a steam/water mixture if separation is effected at the plant instead of at the wellheads. The fluid produced most usually contains incondensable gases (typically CO₂ and H₂S with minor amounts of other gases), the proportion of gas sometimes being so high that economic utilization is not feasible. Economic feasibility also depends on the presence of rock fragments and the chemical composition of the water. Water contained in steam can also be considered an impurity. The engineering schemes for hot water, steam, and the two-phase transmission are described. (30 references) (MCW)

GEOTHERMAL POWER. Wood, B. pp 109-121 of *Geothermal Energy*. Armstead, H. C. H. (ed.). Paris; United Nations Educational, Scientific and Cultural Organization (1973).

Geothermal energy is used for district heating, industry, and other heating applications, but emphasis is on power generation. The geothermal resources have to be exploited where they occur. Electric power generation at the site may then be transmitted. Geothermal power stations include Larderello, Italy; Wairakei and Kawerau in New Zealand; The Geysers and Salton Sea in California, USA; Pauzhetka and Paratunka in the USSR; Matsuoka and Otake in Japan; Pathe and Mexicali in Mexico; and Akureyri in Iceland. (MCW)

GEOTHERMAL DISTRICT HEATING. Einarsson, S. S. (Vermir H/F, Reykjavik). pp 123-134 of *Geothermal Energy*. Armstead, H. C. H. (ed.). Paris; United Nations Educational, Scientific and Cultural Organization (1973).

A history of the application of geothermal energy for heating of houses is discussed for Iceland, Hungary, Japan, New Zealand, and USSR. The economics and technical aspects of the systems are described. The development of the geothermal areas feeding the system in Reykjavik is described, and then principal data regarding the geothermal district heating system are given. The Reykjavik system saves about 150,000 tons of oil annually that would have had to be imported, and the annual cost of heating for the customers is only 60% of the cost of heating with oil. (20 references) (MCW)

INDUSTRIAL AND OTHER APPLICATIONS OF GEOTHERMAL ENERGY (EXCEPT POWER PRODUCTION AND DISTRICT HEATING). Lindal, B. pp 135-149 of *Geothermal Energy*. Armstead, H. C. H. (ed.). Paris; United Nations Educational, Scientific and Cultural Organization (1973).

Industrial applications of geothermal energy are discussed for pulp, paper, wood, sugar, boric acid, salts from seawater, heavy water, fresh water, diatomaceous earths, production of alumina from bauxite, and many other mining processes. The reclamation of minerals and other materials from geothermal fluids is feasible. Agricultural applications include greenhouse and soil warming, animal husbandry and other farm uses, and fish hatching and breeding. Recreational and health applications are described. Usually, the main objective will involve some kind of evaporation, while the side uses may be drying, simple process heating, refrigeration, heating of industrial buildings, or the production of electrical power for the plant. (43 references) (MCW)

CORROSION CONTROL IN GEOTHERMAL SYSTEMS. Marshall, T.; Brathwaite, W. R. pp 151-180 of Geothermal Energy. Armistead, H. C. H. (ed.). Paris; United Nations Educational, Scientific and Cultural Organization (1973).

The main problems of corrosion control in the design and operation of systems for the utilization of geothermal fluids involve interactions between chemical factors, physical factors such as temperature and stress, and the various materials of construction. The most common impurities encountered in geothermal fluids are silica, chlorides, fluorides, borates, sulfates, carbonates, sodium, potassium, lithium, calcium, magnesium, ammonium, hydrogen sulfide, and carbon dioxide. The nongaseous impurities are usually of major significance in water-phase corrosion in geothermal systems, while the gaseous impurities are usually of major significance in steam-phase, condensate and atmospheric corrosion. (50 references) (MCW)

GEOTHERMAL ECONOMICS. Christopher, H.; Armistead, H. pp 161-174 of Geothermal Energy. Armistead, H. C. H. (ed.). Paris; United Nations Educational, Scientific and Cultural Organization (1973).

An attempt is made to assess representative costs applicable to a typical developed geothermal field. Geothermal heat is recovered with a fixed component in price for establishing production costs, no variable component. Limitations are imposed by location. There may be occasions where the availability is nullified by detrimental effects such as poisoned waste fluids. Geothermal heat may be obtained without insoluble technical problems at costs that are far less than for any other form of heat, and of an acceptable grade, leading to cheap power, cheap industry, and sometimes to large savings in foreign currencies. (MCW)

MANAGEMENT OF A GEOTHERMAL FIELD. Bolton, R. S. (Ministry of Works, Wellington, N. Z.). pp 175-184 of Geothermal Energy. Armistead, H. C. H. (ed.). Paris; United Nations Educational, Scientific and Cultural Organization (1973). Methods of estimating the energy potential are discussed and some parameters affecting the potential include stored heat and natural heat flow. The methods and effects of exploitation are related to the potential for the recovery of the energy. The primary effects of exploitation are discussed and examples are cited for results at Wairakei, New Zealand; Larderello, Italy; and Laugavegur, Iceland. The secondary effects of exploitation include natural activity, ground movement, pollution, and chemical deposition. Chemical deposition can reduce output or be a problem for the disposal of waste water. Tourism is a secondary effect. Measurements and records are made, but results seem to bypass mathematical tools. Perhaps as more geothermal fields are exploited, theoretical and mathematical background will expand. (21 references) (MCW)

N74-17801# California Univ., Riverside. Inst. of Geophysics and Planetary Physics.
FEASIBILITY STUDY FOR DEVELOPMENT OF HOT-WATER GEOTHERMAL SYSTEMS. Fr. Technical Report James B. Combs. Mar 1973 126 p refs (Grant AF-AFOSR-2393-72; ARPA Order 2184) (AD-771016; IGPP-UCR-73-18; AFOSR-73-2070TR) Avail: NTIS CSCL 10/2

The investigation has been directed toward a feasibility study for the development of hot-water geothermal systems for potential Department of Defense use as an energy source. The research effort has included the gathering of both scientific and engineering data. The world-wide occurrence of both known and probable sites of hot-water (water-dominated) geothermal systems particularly in relation to United States Department of Defense installations are reviewed and discussed. Included are the geological settings and the types of detection techniques that are necessary to delineate geothermal systems. GRA

N74-21691 #

(LA-UR-73-1075) **POTENTIAL FOR HOT-DRY-ROCK GEOTHERMAL ENERGY IN THE WESTERN UNITED STATES.** Brown, D. W. (Los Alamos Scientific Lab., N. Mex. (USA)). 25 Jul 1973. Contract W-7405-eng-36. 22p. Dep. NTIS \$3.25.

The U. S. Geological Survey has identified 1.8 million acres (2800 square miles) of western lands as "having a significant potential for geothermal development." The LASL for the past 2 years has been actively investigating the potential for and problems associated with extracting geothermal energy from the much more numerous regions of the western United States containing hot, but essentially dry, rock at moderate depths. A recent survey reveals that about 7% of the 13-state area comprising the Western Heat Flow Province—about 95,000 square miles—is underlain, at a depth of 5 km (16,400 ft), by hot rock at temperature levels above 290°C (>550°F). In the Los Alamos concept, a man-made geothermal reservoir would be formed by first drilling into suitably hot rock, and then creating a very large surface area for heat transfer using conventional hydraulic fracturing techniques developed by the oil industry. After forming a circulation loop by drilling a second hole into the top of the fractured region, the heat contained would be convected to the surface by the buoyant circulation of water, without the need for pumping. The water in the Earth loop would be maintained as a liquid throughout by pressurization at the surface, both increasing the amount of heat transport up the second (withdrawal) hole, and enhancing the rate of heat removal from the fractured reservoir, when compared to steam. Thermal stresses resulting from the cooling of the hot rock in such a man-made reservoir may gradually enlarge the initial fracture system so that its useful lifetime will be greatly extended beyond the planned 10 to 15 years provided by the original reservoir. If these thermal stress cracks grow preferentially downward and outward into regions of hotter rock, as seems probable, the quality of the geothermal source may actually improve as energy is withdrawn from it. (auth)

TITLE: A Practical Application of Geothermal Steam

AUTHOR: Finney, J.P.

CORPORATE AUTHOR: Pacific Gas & Electric Co.,

Geysers Geothermal Power Project

PUBLICATION DESCRIPTION: Public Utilities

Fortnightly, 93(3), 18-20

PUBLICATION DATE: 1973, January 31

ABSTRACT: A brief description is given of the use of geothermal energy around the world. A

more detailed account is given of the history and operation of the Geysers project in

California. The capacity of this

installation will be more than doubled by

1977, when more than 900 MW will be

generated. The Federal government should

concentrate research efforts on areas less

well developed, such as "dry" geothermal

energy and the binary power cycle, which uses

hot water. (JBC)

PUBLIC POWER COUNCIL PRESENTS 10-YEAR GEOTHERMAL PROGRAM.

Geotherm. Energy Mag.: 1: No. 2, 30-32 (Sep 1973).

It is advised that a joint industrial-government program be approached for a total geothermal research and development program. Existing geothermal installations have environmentally undesirable discharges of gas, liquids, and minerals. Research, development, and evaluation of well design appear necessary to avoid well failure that may result in uncontrolled surface or subsurface release of undesirable materials. (MCW)

TITLE: The Total Flow Concept For Recovery of

Energy From Geothermal Hot Brine Deposits

AUTHOR: Austin, A.L.; Higgins, G.R.; Roward, J.H.

CORPORATE AUTHOR: Lawrence Livermore Laboratory

ADDRESS: University of California, Livermore, CA

PUBLICATION DESCRIPTION: Report No. UCRL-51366, 39 p.

PUBLICATION DATE: 1973, April 3

SPONSOR: U.S. Atomic Energy Commission

ABSTRACT: This report describes a new method for producing electrical power from the energy stored in hot brine deposits. Of the three forms of geothermal energy, the hot brine resource has the greatest potential for development of a viable long-range geothermal energy supply. It is a large energy source with recovery and conversion requiring only moderate extensions of existing technologies. The proposed method is developed specifically for application to the brines of the Salton Sea geothermal area, where enough energy is stored to provide at least 100,000 MW electrical generation capacity for more than 20 yr.

DRY GEOTHERMAL WELLS: PROMISING EXPERIMENTAL RESULTS

Hammond, A. L. (Dept. of Interior, Washington, DC). Science: 182: No. 4107, 43-44 (5 Oct 1973).

Experimental results are described for a test well drilled 780 m into granite rock at one edge of a huge volcanic caldera in the Jemez Mountains of northern New Mexico by researchers from

LANL, an Atomic Energy Commission facility. Water was pumped under pressure into a section of the well to open cracks in the surrounding rock. The hydrofracturing technique had not been demonstrated in granite or other crystalline rock formations.

These dry geothermal deposits are believed to constitute a resource at least ten times as large as deposits permeated by ground water. The economic feasibility of the hydrofracturing experiments is discussed. (MCW)

FULL STEAM AHEAD FOR GEOTHERMAL ENERGY.

J. Henahan.

New Scientist, Jan. 4, 1973, p.16-19.

Power companies in the US are looking for alternative sources of energy. Geothermal wells are high on the list.

N74-12183# Southern Methodist Univ., Dallas, Tex. Geophysical Lab.

DEVELOPMENT OF GEOTHERMAL RESERVOIRS FROM OVER-PRESSURED AREAS BENEATH THE GULF COASTAL PLAIN OF TEXAS. A FEASIBILITY STUDY OF POWER PRODUCTION FROM OVERPRESSURED RESERVOIRS

Final Report

Eugene Herrin Mar. 1973 149 p refs

(ARPA Order 2184)

(AD-768855; AFOSR-73-1344TR) Avail: NTIS CSCL 08/7

It is the purpose of the present study to determine the feasibility of locating a pilot project in the Texas Gulf Coast area for the purpose of tapping the overpressured aquifers and transforming the thermal and mechanical energy into electrical power. Three areas in south Texas were given particular attention for their feasibility of being the site of the pilot project. These are the Sebastian area in northwest Cameron County, the Port Mansfield area in eastern Willacy County, and the Corpus Christi area.

1973

GEOTHERMAL POWER: CAN IT HELP SOLVE THE ENERGY CRISIS.

E.F. Wehlage.

Machine Design, May 3, 1973, p. 30-32, 34-36.

73VI8730

Geothermal energy: review of research and development

UNESCO, Paris: UNESCO, (1973). 188 pp. This work comprises a symposium of papers by different authors covering the following subjects: the nature and basic theories of geothermal energy; geology and exploration; winning of geothermal fluids; geothermal power; district heating; industrial applications; geothermal economics; and management of a geothermal field.

BEOWAWE STILL ROARS: REPROACH AND RENAISSANCE

Wehlage, E. F. Geotherm. Energy Mag.; 1: No. 2, 14-18 (Sep 1973).

Beowawe Hot Springs is located 250 miles northeast of Reno, Nevada. Exploratory drilling occurred in the period 1959 to 1965 by Magma Power Co. and Associates and Vulcan Thermal Power Company. Mystery now tells the ownership of the Beowawe Little Geysers, but visits in 1972 and 1973 reveal their adaptability for a fine geothermal laboratory. (MCW)

GEOTHERMAL TEST GENERATOR UNIT: THIRD ELECTRIC GENERATOR IN NORTH AMERICA. Wehlage, E. F. Geotherm. Energy Mag.; 1: No. 1, 27-28 (Aug 1973).

The helical rotary screw expander was developed as a geothermal fluid prime mover for driving a generator adapted for reverse operation from a relatively new type of air and gas compressor developed in Sweden as the Lyschalm rotary-screw compressor. Test runs were made at Cerro Prieto and indicate a great potential for practical applications on a larger scale for geothermal power generation. The expander system produces power from hot, mineral-depositing brines. The system upgrades the current power recovery, reduces current plant costs, simplifies current installations, and allows fresh water extraction. (MCW)

1973

POTENTIAL FOR THE PRODUCTION OF POWER FROM GEOTHERMAL RESOURCES. Smith, M. C. (Los Alamos Scientific Lab., NM). Geotherm. Energy Mag.; 1: No. 2, 46-51 (Sep 1973).

Testing is being carried out at the Los Alamos Scientific Laboratory to investigate the possibilities, problems, and probable usefulness of man-made geothermal-energy systems in hot dry rock. The geothermal energy in the Earth's crust is the largest reservoir of directly usable clean energy accessible to man. The extraction system, potential, and costs are discussed. Equipment and techniques to make this energy reservoir useful already exist. (MCW)

also N74-21690#

(AEC-tr-7475) PROCESS FOR THE SIMULTANEOUS UTILIZATION OF GEOTHERMIC AND HYDRODYNAMIC ENERGY. Tavip, J. E. Indl. Translation of Disposithuo para el aprovechamiento simultaneo de la energia geotermica y la hidrodinamica. 7p. Dep. NTIS \$3.00.

A process is described for the utilization of hydrodynamic energy produced by water falling through a pipe inserted deeply into the Earth's crust at a point where the high temperature will produce steam and is returned to the Earth surface through another pipe as steam. The waterfall created by this perforation is utilized by turbines suitable for the production of electric energy while the steam produced spurts from the surface of the Earth and can be used as a source of energy with multiple applications. (MCW)

(LA-UR-73-926) POTENTIAL FOR THE PRODUCTION OF POWER FROM GEOTHERMAL RESOURCES. Smith, M. C. (Los Alamos Scientific Lab., N. Mex. (USA)). 1973. Contract W-7405-eng-36. 18p. Dep. NTIS \$3.00.

The nature and magnitude of the hot, dry rock geothermal energy resources are such that within the next 10 to 15 years it could begin to contribute significantly to the solution of some of our nation's most urgent energy, pollution, and balance-of-payments problems. A program to investigate and develop this resource was undertaken by the Atomic Energy Commission at Los Alamos Scientific Laboratory, and initial results from that program are described. It appears that the equipment and techniques required to make this vast energy reservoir useful already exist, and that a convincing demonstration of its usefulness is possible within less than five years. (auth)

GEOTHERMAL GEOPRESSURE RESOURCES AND PROBLEMS OF THE GULF COAST. Romans, W. A. Geotherm. Energy Mag.: 1, No. 1, 39-42(Aug 1973).

Technology exists to pump large quantities of water up to pressures of 3500 to 4000 lbs/in² for supercritical boilers in fossil-fueled steam power plants. This pump experience can be applied to a high-pressure water turbine that would extract the pressure energy from the geopressured fluid and discharge the fluid at conditions of pressure and temperature such that its thermal energy could be extracted. Geopressured fluids are normally saturated with methane and could be economically recovered. Hot interstitial water in deep overpressured sedimentary basins of greater-than-normal temperatures exist in the Gulf Coast from the Rio Grande to eastern Mississippi. The geology and hydrology of the region are reviewed. Abundant data are available for geopressured gas reservoirs. With favorable conditions, it is expected that wells could be made to produce 3 to 5 million gallons/day of water at 350 to 400°F, having a closed-in pressure at the well head of 4,000 to 5,000 psig, the water containing less than 10,000 mg/l dissolved solids, and 0.3 to 1.0 standard cubic feet of hydrocarbon gas per gallon of water. (MCW)

(UCRL-74807) SOME ELEMENTS OF THE NORTHERN GULF OF MEXICO BASIN GEOPRESSURE ENERGY RESOURCE.

Myers, B.; Nelson, R.; Howard, J.; Austin, R. (California Univ., Livermore, Lawrence Livermore Lab). 7 Jun 1973. 27p. (CONF-730659-1). Dep. NTIS \$3.50.

From geothermal hearings conference, Washington, District of Columbia, USA (14 Jun 1973).

It has been shown that there may be a very substantial energy resource in the Gulf of Mexico Basin in two forms, geopressured water and contained natural gas. Economic analyses show that the most conventional scheme, the 6 $\frac{1}{2}$ -inch well pipe-duplex conversion system, could give electric power costs in the range of two to four times present electric power costs to lower levels. The magnitude of the stored energy in these geopressure regions of Texas and Louisiana, the representative power cycles for conversion of this stored energy, and the economics of the situation are studied. (MCW)

N74-15240 Geological Survey, Washington, D.C.

GEOTHERMAL RESOURCES.

L. J. P. Muffler. In: *US Mineral Resources 1973* p 251-261 refs. (For availability see N74-15214 06-18)

The geothermal resource base is defined as all the heat above 15 C in the earth's crust, but only a small part of this resource base can properly be considered as a resource. The magnitude of the geothermal resource depends on the evaluation of many physical, technological, economic, environmental, and governmental factors. The physical factors that control the distribution of heat at depth can be evaluated, at least rudely. More tenuous are the assumptions of technology, economics, and governmental policy. These assumptions are critical to geothermal resource estimation.

Author

MEXICO TURNS TO STEAM ENERGY: CERRO PRIETO. Masley, C. C. Geotherm. Energy Mag.: 1, No. 1, 22(Aug 1973).

The 75,000 kW generating plant at Cerro Prieto, Mexico is beginning operation using superheated steam from depths of 4,000 feet surrounding the extinct volcano. The experiment began in 1968. Steam used to turn the Japanese-made turbogenerators can be condensed into salt-free potable water, and ultimately used for irrigation. The Mexicali Valley south of Cerro Prieto is an extension of Imperial Valley. (MCW)

GEOTHERMAL POWER GENERATION USING THE BINARY CYCLE. Holt, B.; Hutchinson, A. J. L.; Cortez, D. B. Geotherm. Energy Mag.: 1, No. 1, 45-58(Aug 1973).

Geothermal resources of the world are comparable in magnitude to fossil fuel and nuclear energy resources. It is evident that the technology exists to exploit economically many of the world's known geothermal reservoirs and that the impact on the environment will be minimal. A flowsheet for a typical binary power cycle is shown. The geothermal fluid is flashed and steam is flashed and steam is separated from the hot brine. Both streams are used to heat and vaporize the power fluid that is passed through a turboexpander and condensed with cooling water. The power fluid is then pumped to the upper working pressure and reheated to complete the cycle. The brine may be reinjected and the steam condensate used for cooling tower makeup, sold as fresh water, or reinjected with the brine. At the San Diego Gas and Electric plant the working fluid will be isobutane that will be heated by flashed steam and brine and condensed with cooling water. No expansion turbine or generator will be installed initially. (MCW)

HAWAII VOLCANO ENERGY. Sheets, G. M. Geotherm. Energy Mag.: 1, No. 1, 23-24(Aug 1973).

The exploration and development of volcano energy in Hawaii was proposed by the center for Engineering Research at the University of Hawaii. Funds have been pledged by private sources, federal agencies, State of Hawaii, and Hawaii County to accomplish minimal necessary investigation of geological, engineer, socio-economic, and environmental base-line data concerning the potential for access to geothermal energy. The geology of the islands is briefly discussed. (MCW)

(ORNL-TM-4135) EVAPORATIVE HEAT TRANSFER IN VERTICAL TUBES AT GEOTHERMAL BRINE CONDITIONS: A PRELIMINARY INVESTIGATION. Harley, P. H.; Eisenberg, D. M. (Oak Ridge National Lab., Tenn. (USA)). Jun 1973. Contract W-7405-eng-26. 37p. Dep. NTIS \$4.00.

Overall heat-transfer coefficients were obtained in a single-tube loop for a smooth tube and two fluted tubes proposed for use in a geothermal brine upflow VTE pilot plant. Tests were run at steam temperatures from 250 to 390°F, flow rates of 0.5 to 2.5 gpm, and steam to brine ΔT s of 10 to 30°F using demineralized water and 3% NaCl solutions. In each case the liquid entering the tube flashed through a ΔT equal to the steam-brine ΔT . The tubes tested were a 1/4-in. smooth stainless steel tube, a 1-in. double-fluted CuNi tube, and a 1/4-in. double-fluted Al brass tube. Average heat transfer coefficients using 3% NaCl were as follows: for the stainless steel tube, 550 Btu/hr/°F/ft² at 250 to 765 at 390°F; for the CuNi tube, 2000 at 250 to 2600 at 390°F; for the aluminum brass tube, 1750 at 250 to about 2650 at 390°F. Flow rate and ΔT , in general, had only small effects on the coefficients. (auth)

GEOTHERMY AND ITS FUTURE IN INDONESIA. Zena, M. T. (Inst. of Tech., Bandung, Indonesia). Proc., Inst. Teknol. Bandung; 7. No. 1, 27-40(1973).

The basic concept of a commercial steam-field is discussed and potential areas are indicated in a map. It is found that not less than 24 geothermal areas are prospectable, but very little is known about the exact potential of Indonesia in the field of geothermy. Anticipating the rising demand in electricity within the context of the broader industrialization program of Indonesia and the limitation of its fossil fuel reserve, it is suggested that all possibilities for utilizing different kinds of energy, including geothermy, should be explored as far as possible. (auth)

W74-21689 #

(LA-UR-73-1316) GEOTHERMAL ENERGY. Smith, M. C. (Los Alamos Scientific Lab., N. Mex. (USA)). 1973. Contract W-7405-eng-36. 9p. Dep. NTIS \$3.00.

Dry hot rock in the Earth's crust represents the largest and most broadly distributed reservoir of usable energy accessible to man. The engineering equipment and methods required to extract and use this energy appear to exist and are now being investigated actively at LASL. At least for deep systems in relatively impermeable rock, not close to active faults, the extraction of energy from dry geothermal reservoirs should involve no significant environmental hazards. The principal environmental effects of such energy systems will be those associated with the surface facilities that use the geothermal heat; these will be visual in land use, and in the thermal-pollution potential of low-temperature power plants. The energy extraction system itself should be clean, safe, unobtrusive, and economical. (auth)

BLADELESS TURBINES: A GEOTHERMAL PRIME-MOVER AND RE-INJECTION PUMP. Posselt, C. R. (Federal Engineering and Manufacturing, Inc., San Diego, CA). Geothermal Energy Mag.; 1. No. 1, 20-21(Aug 1973).

The success of economically converting geothermal energy depends upon the solution to the problem of handling a two-phase effluent of steam and hot brine for recovery of energy. The effluents contain high percentages of superheated water and dissolved solids. More costly closed or binary cycle systems that utilize some form of heat exchange system with attendant penalties in system efficiency and deposition problems are necessary. The new bladeless turbine developed by U. S. Federal Engineering and Manufacturing, Inc., of San Diego discards conventional impulse and reaction design principles in favor of "boundary layer drag" to accomplish the energy conversion from steam, or hot brine, to rotating shaft power without any "impingement". The hot steam and liquid are brought into the turbine case by suitable peripheral nozzles at a tangent to a number of flat discs that are fixed on a rotating shaft. The hot effluent with a high kinetic energy is directed inwardly with a helical path until discharged through holes in the discs located near the shaft. (MCW)

TITLE: Nature's Teakettle - Geothermal Energy For the People

AUTHOR: Seall, H.
CORPORATE AUTHOR: Geothermal Information Services
ADDRESS: 318 Cherrywood St., West Covina, CA 91791

PUBLICATION DESCRIPTION: 213 p.

PUBLICATION DATE: 1973

ABSTRACT: The author attempts to answer the question "What is geothermal energy?" in terms the layman can understand. Included in the discussions are: the energy problem and the blackouts; the nature of energy; how turbines operate; the geological structure of the earth; state of the art of geothermal plumbing; water problems and desalination; nuclear energy; pollution; hot rocks; utilization of geothermal energy throughout the world; proposed legislation; and what public opinion can do. A glossary of energy and geothermal terms and a directory of information sources are included. (RPG)

GEOTHERMAL: THE PROBLEM OF DEFINITION. Summers, W. K. Geothermal Energy Mag.; 1. No. 1, 29-33(Aug 1973).

The question of ownership has been a major deterrent to the development of geothermal resources in the United States. Federal legislation says that geothermal rights are a separate entity on federally administered lands. The Geothermal Steam Act of 1970 says that geothermal steam and associated geothermal resources are the products of geothermal processes in geothermal formations. The references believe that the word "geothermal" clearly indicate that Congress believes that the word "geothermal" implies the upper end of a temperature scale—which scale is not specified, nor are we told at what point non-geothermal leaves off and geothermal begins. Researchers differ on classification of water temperatures, depending on their interests. Renewability and the question of rights are discussed. (MCW)

(EIS-CA-73-1681-F-1-GA) GEOTHERMAL LEASING PROGRAM. Volume I. Promulgation of Leasing and Operating Regulations. Final Environmental Impact Statement. (Department of the Interior, Washington, D. C. (USA)). 24 Oct 1973. 519p. GPO \$4.20.

Volume I of this statement primarily relates to the promulgation of leasing and operating regulations for implementation of the geothermal leasing program as authorized by the Geothermal Steam Act of 1970. The proposal is described in Chapter I. The national energy situation, geothermal energy resources and their potentials, description of resource development and production phases, and a broad description of the environmental setting of the western states are included in Chapter II. The promulgation of leasing and operating regulations, the environmental impacts of the proposed action, mitigating measures, adverse impacts which cannot be avoided, the relationships between local short-term uses of man's environment and maintenance and enhancement of long-term productivity, and irreversible and irretrievable commitments of resources are discussed in detail in Chapter III. Chapter IV includes discussions of alternatives for timing of actions, environmental provisions of regulations, leasing options, Federal and private exploration and development, and electrical energy sources. (GRA)

(EIS-CA-73-1681-F-2-GA) GEOTHERMAL LEASING PROGRAM. Volume II. Leasing of Geothermal Resources in Three California Areas. Final Environmental Impact Statement. (Department of the Interior, Washington, D. C. (USA)). 24 Oct 1973. 547p. GPO \$5.85.

This volume of the Geothermal Leasing Program final impact statement contains the individual environmental statements for the leasing of federally owned geothermal resources for development in three specific areas: (a) Clear Lake-Geysers; (b) Mono Lake-Long Valley; and (c) Imperial Valley, all in California. It also includes a summary of the written comments received and departmental responses relative to the Draft Environmental Impact Statement issued in 1971; comments and responses on the Draft Environmental Impact Statement; consultation and coordination in the development of the proposal and in the preparation of the Draft Environmental Statement; and coordination in the review of the Draft Environmental Statement. (GRA)

(EIS-CA-1681-F-3-GA) GEOTHERMAL LEASING PROGRAM. Volume III. Appendices A Through H. Proposed Geothermal Leasing and Operating Regulations. Final Environmental Impact Statement. (Department of the Interior, Washington, D. C. (USA)). 24 Oct 1973. 701p. GPO \$5.60.

The following topics are discussed: July 23, 1973, proposed leasing regulations; July 23, 1973, proposed operating regulations; comments on July 23, 1973, proposed regulations; November 28, 1972, proposed operating regulations; comments on November 28, 1972, proposed operating regulations; July 23, 1971, proposed leasing and operating regulations; May 3, 1972, proposed unit plan regulations; summary of comments and departmental responses; vapor dominated hydrothermal systems; classification of public lands. (GRA)

(EIS-CA-73-1681-F-4-GA) GEOTHERMAL LEASING PROGRAM. Volume IV. Appendix I. Comments on Draft Impact Statement and Proposed Regulations. Final Environmental Impact Statement. (Department of the Interior, Washington, D. C. (USA)). 24 Oct 1973. 728p. GPO \$5.65.

This volume contains comments received from Federal, State, local and individual interests on the leasing and operating regulations and the Draft Environmental Impact Statement for the Geothermal Leasing Program and the supplement to the draft statement. (GRA)

Heat rejection from geothermal power plants. J.H. Anderson (Sea Solar Power Inc., York, Pa., USA).

EOS Trans Am. Geophys. Union (USA), vol 54, no 11, p.1065 (Nov. 1971) (American Geophysical Union 1973 Fall Annual Meeting (abstracts only). San Francisco, Calif., USA, 10-13 Dec. 1973). Discusses the heat rejection from geothermal and other low temperature power plants. The low thermodynamic efficiency of such plants requires greater heat rejection than is necessary for conventional fossil plants. They are also much more sensitive to the temperatures available for cooling systems. New cooling systems are needed, which can provide lower temperatures at lower costs than present systems. Such systems are discussed with reference to both power and water requirements.

GEOTHERMAL OPERATING EXPERIENCE AT GEYSERS POWER PLANT. Matthew, P. (Pacific Gas and Electric Co., San Francisco). J. Power Div., Amer. Soc. Civil Eng.; 99: No. PO2, 329-338 (Nov 1973).

Operating experience over 12 yr at the Geysers Power Plant has demonstrated that geothermal electric power generation can be reliable and economical. Location, terrain, environment, personnel considerations, and operating requirements have created new and unique problems compared with traditional thermal power generation practices. Common interests and goals of the steam supplier and the power plant operator have resulted in their solutions. Much has been learned about the selection of equipment and materials that will be used to make future installations more reliable and perhaps reduce power costs. Similar to other means of generating electric power, geothermal generation has certain inherent attributes and liabilities but when viewed in proper perspective with objectivity is sound and economical. (auth)

GEOTHERMAL ENERGY SYSTEM. McCabe, B. C. to Magma Energy Inc.). US Patent 3,757,516. 11 Sep 1973. Filed date 14 Sep 1971. 24p.

The method and apparatus for the nonpolluting generation of electrical power by the economic utilization of geothermal energy that is accessible through widespread sources of regenerative geothermal hot water are described. A well provides access to a geothermal hot water source having a temperature substantially above the flash point for atmospheric pressure, the hot water being conducted through heat exchangers wherein its heat energy is transferred to a power fluid employed in a closed Rankine heat engine cycle to generate electrical power, the water then being injected back into the aquifer. The geothermal hot water is pressurized by deep well pump means to a discharge pressure above its saturated vapor pressure for the source temperature, and a pressure gradient above the saturated vapor pressure is maintained through the heat exchangers, whereby the hot water is restrained from flashing into steam throughout its circuit, thereby avoiding any substantial temperature drop between the source and the heat exchangers and preventing release of any substantial mineral deposits at any point in the circuit. The very small expenditure of power required for such pressurization produces a large increase in total plant power output and efficiency by, among other things, (1) providing a low temperature power fluid Rankine cycle, (2) avoiding fouling of the well and surface equipment with mineral deposits, (3) deriving power from all of the geothermal fluid rather than just a stream fraction thereof, (4) allowing use of a power fluid that is particularly efficient in the available temperature range, and (5) avoiding degeneration of the power fluid source and ecological damage by returning the geothermal fluid to the aquifer. (Official Gazette)

(WASH-1281-8) GEOTHERMAL ENERGY PROGRAM. Subpanel Report VIII Used in Preparing the AEC Chairman's Report to the President. (USAEC, Washington, D. C.). 13 Nov 1973. 192p. Dep. NTIS \$12.75.

Only one resource type is presently being used to produce power in the U. S.—dry steam generating 400 MWe at The Geysers near Santa Rosa, California. Six other types—brines at high temperature and low salinity, high temperature and high salinity, low temperature and low salinity, and in geopressed reservoirs, plus dry hot rock at shallow depth and in deep, normal-gradient formations—are potentially available for economic energy recovery. The program plan calls for a government budgetary obligation of \$40 million during FY-75 coupled with an industrial commitment of \$11.7 million. The five-year budgetary obligations are estimated to be \$185 million for the government and \$60 million for industry. The complete five-year plan plus the balance-to-complete funds is presented. Under this program plan, demonstration plants using four of the six advanced resource types will be completed and operated, jointly with industry, to obtain engineering and economic data. Construction work will be underway on a demonstration plant for a fifth resource type, dry hot rock, and engineering data in support of the design of a sixth plant employing normal-gradient formations will have been collected. It is expected that information from all these systems will accelerate commercialization of geothermal energy. (auth)

1973

(LBL-2102) COMPARISON OF ELEMENTARY GEOTHERMAL-BRINE POWER-PRODUCTION PROCESSES. Green, M. A.; Laird, A. D. K. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 2 Aug 1973. Contract W-7405-eng-48. 34p. (CONF-730846-1). Dep. NTIS \$3.75.

From applied technology geothermal committee meeting, Idaho Falls, Idaho, USA (7 Aug 1973).

A comparison of three simple geothermal power-production systems shows that the flashed steam and the compound systems are favored for use with high-temperature brines. The binary system becomes economically competitive only when used on low-temperature brines (enthalpies less than 350 Btu/lb). Geothermal power appears to be economically attractive even when low-temperature brines are used. (auth)

GEOTHERMAL ENERGY. Resources, Production, Stimulation. Kruger, P.; Otte, C. (Eds.). Stanford, CA: Stanford University Press (1973). 368p. \$17.50.

Abstracts were prepared for eighteen papers presented at the special symposium held by the American Nuclear Society in June 1972. Individual papers discuss available and potential resources throughout the world, methods of exploration and evaluation, geological and geochemical character of the resources, problems in developing the several types of resources, the current status of geothermal energy production in the US and elsewhere, potential methods for more efficient production, the impact on the environment, and possible uses as a water resource. The final paper reviews the needed areas of research and Federal efforts to coordinate exploration, research, and development. (MCW)

GEOTHERMAL WORLD DIRECTORY. Meadows, K. F. (Comp.). Glendora, CA: Geothermal World Directory (1973). 242p. \$15.00.

The World Directory includes information from all pertinent states in the United States on the state-of-the-art of geothermal energy. All legislators, commercial and industrial firms, individuals, and public utilities serving actively in geothermal energy are listed. U. S. and foreign educational institutions performing in the geothermal field are listed. The state-of-the-art in geothermal energy in each country of the world is summarized. International societies, agreements, and legislation are given. Financing data include information on world financing and comparative energy costs. (MCW)

N74-12696# Los Alamos Scientific Lab., N.Mex.
SOME INTERFACES IN RESOURCE UTILIZATION
 L. P. Reing [1973] 16 p refs Presented at Symp. on Econ. Develop. vs. Environ. Quality in the Southwest, Lubbock, Tex., 19-20 Apr. 1973; sponsored by Comm. on Desert and Arid Zone Res. of the Am. Assoc. For the Advan. of Sci. (Contract W-7405-eng-36)
 (LA-UR-73-570; Conf. 730440-1) Avail: NTIS HC \$3.00

Los Alamos Scientific Laboratory is engaged in programs to explore the ways of extracting useful power from the heat of the earth's crust; to demonstrate the feasibility of superconducting transmission lines; and to develop a rock-melting penetrator, or subterranean, expected to be capable of creating long tunnels in rock. The tunnels, lined with the glass-like melted rock created by passage of the subterranean, might form excellent conduits for underground transmission lines, as well as serving in the exploitation of geothermal energy. A project to exploit the vast underground reservoir of saline water in New Mexico is described. The project TRG is based on desalination by means of geothermal or nuclear energy to furnish New Mexico with water and electric power.

(LA-3289-MS) **GEOHERMAL ENERGY.** Smith, M. C. (Los Alamos Scientific Lab., N. Mex.). May 1973. Contract W-7405-eng-36. 31p. Dep. NTIS \$4.00.

Geothermal energy and its present and projected uses in terms of economics, current technology, and environmental impact are discussed. Both the advantages and disadvantages of geothermal energy and its conversion to electricity are presented briefly. (auth)

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 1973
Intersociety Energy Conversion Engineering Conference, 8th Philadelphia, Pa., 1973. Proceedings. New York, American Institute of Aeronautics and Astronautics [1973]
 847 p. illus. 29 cm.
 Held at: University of Pennsylvania, Philadelphia, Pa., August 13-16, 1973.
 Sponsored by: American Institute of Aeronautics and Astronautics [and others]

A Thermodynamic Power Cycle for Recovery of Geothermal Energy -
 M. T. HOWERTON.....P.382.....

GEOHERMAL POWER - THE GREAT LAND RUSH OF '73.
 Forbes, Jan.15,1973, p.31.

THE POTENTIAL FOR GEOTHERMAL POWER.
 Business Wk, Mar.17,1973, p.74,75.

GEOHERMAL ENERGY STUDY BACKED BY \$250,000.
 New Scientist, June 28,1973, p.814.

New sources of power - geothermal resources. J. Barnea. Conference on World Energy Supplies, London, England, 18-20 Sept 1973 (London, England: Financial Times, 1973). 7pp.
 Discusses how the geothermal energy is harnessed to generate electric power, to provide for district heating, to provide heat for green-houses and so on, in more than 15 countries today. Large-scale commercial development of geothermal resources is under way in the United States, Japan, Italy, Mexico, New Zealand, El Salvador, Chile, Kenya, and a number of other countries (no refs.)

(AD-766855-1) **DEVELOPMENT OF GEOTHERMAL RESERVOIRS FROM OVERPRESSURED AREAS BENEATH THE GULF COASTAL PLAIN OF TEXAS. A Feasibility Study of Power Production From Overpressured Reservoirs.** Final Report. Herrin, E. (Southern Methodist Univ., Dallas, Tex. (USA)). Mar 1973. 148p. (AFOSR-TR-73-1344). NTIS \$9.50.

It is the purpose of the present study to determine the feasibility of locating a pilot project in the Texas Gulf Coast area for the purpose of tapping the overpressured aquifers and transforming the thermal and mechanical energy into electrical power. Three areas in south Texas chosen were the Sebastian area in northwest Cameron County, the Port Mansfield area in eastern Willacy County, and the Corpus Christi area. (GRA)

N73-27324# Joint Publications Research Service, Arlington, Va.

DEEP-SEATED HEAT FROM THE EARTH

I. M. Dvorov 12 Jul. 1973 148 p refs Transl. into ENGLISH from the book "Glubinnoye Teplo Zemli" Moscow, Nauka, 1972 p 9-104 and 141-205 (JPRS-59496) Avail: NTIS HC \$9.50

Basic scientific trends are discussed, such as: regional distribution and conditions of geothermal field formation in a zone accessible to direct measurements; development and improvement of the equipment and procedures in geothermal observations; deep-seated thermal processes; and social-economic utilization of earth's heat.

(ANCR-1129, pp 385-389) **GEOHERMAL POTENTIAL OF THE SNAKE RIVER PLAIN AREA.** Kunze, J. F.; Brugger, R. M. Dec 1973.

In Nuclear Technology Division annual progress report for period ending June 30, 1973.

Development of the area in and around the National Reactor Testing Station will be proposed if investigations confirm the rich and economically accessible geothermal fields of mostly dry hot rock. The tapping of energy from hot dry rock or from deep poorly convective wet fields accessible at depths from 5 to 20 thousand feet should offer the potential for a virtually inexhaustible supply of energy for electric power production. The area is in a sparsely populated area, but is conducive to geothermal development for creating a model city with a clean environment. (MCW)

(AD-764523-9) **PROGRESS REPORT ON ELECTRICAL RESISTIVITY STUDIES, COSO GEOTHERMAL AREA, INYO COUNTY, CALIFORNIA.** Furgeson, R. B. Jun 1973. 70p. (NWC-TP-5497). NTIS \$3.50.

The first phase of an electrical geophysical survey of the Coso Geothermal Area is described. The objective of the survey was to outline areas of anomalously conductive ground that may be associated with geothermal activity and to assist in locating drilling sites to test the geothermal potential. (GRA)

GEOHERMAL POWER PROJECT OF PACIFIC GAS AND ELECTRIC COMPANY AT THE GEYSERS, CALIFORNIA.

J.P. Finney, F.J. Miller, and D.B. Mills.

IEEE Trans. Power App. & Syst., v.PAS-92, 1973, p.108-

Utilization of the earth's geothermal energy resources for production of electric power has been achieved in several areas throughout the world. The only commercial development in operation in North America is at "The Geysers" north of San Francisco. A 12 MW unit commenced operation in 1960, and additional units have been added bringing the total capacity to 192 MW. Design and construction now under way will increase this to 522 MW by the end of 1974. There are plans for continuing increments of approximately 100 MW per year as steam reserves are developed. The steam supply, mechanical and electrical features, operating experience, and special problems are described.

Geothermal Energy, A National Proposal for Geothermal Resources Research, Workshop, September 18-20, 1973. NSF-RA-N-73-003.

(Contact NSF Office of Public Technology Projects,
Room 405, or RANN Document Center, Room 601,
G 1800 G St. N.W., Wash., D.C. 20550.)

(ANCR-1129, pp 390-395) CONCEPTUAL DESIGN OF A GEOTHERMAL DEMONSTRATION PLANT FOR THE RAFT RIVER BASIN. Kunze, J. F.; Miller, L. G.; Nedli, D. T. Dec 1973.

In Nuclear Technology Division annual progress report for period ending June 30, 1973. A preliminary conceptual design on a geothermal power plant operating with thermal water at 150°C in the Raft river valley is described. Current power plant technology allows for flashing some of the hot water to steam and to run a low pressure naval type turbine. Much heat is left in the water, and the goal is to recover the residual heat. Two possible methods are given. Calculations are given for steam obtained directly (hopefully at about 300°F) and for steam produced by flashing water from 69 psia down to 35 psia. The design of the geothermal single stage steam cycle is shown. (MCW)

MULTI-PURPOSE UTILIZATION OF GEOTHERMAL RESOURCES. Various examples are cited which illustrate the multiple applications of geothermal hot water in many parts of the world. The development of geothermal energy has been marked by progress in two main directions: power has been produced from geothermal steam and several applications have been found from geothermal water. It is argued that a multi-purpose total energy utilization of geothermal resources could result in the following: steam could be separated in a conventional manner and used to supply cheap power; carbon dioxide could be extracted from the gases and used for refrigeration and food processing; in the same manner, hydrogen sulphide could be utilized to obtain sulfur. Hot water from the wells could supply a desalination plant; the produced fresh water would not only supply the needs of the local population but also a high-market value gardening operation using irrigation techniques. The hot water could also be used to provide air conditioning and refrigeration. The effluent from the desalination could be used for minerals extraction, and the resulting minerals could be processed taking advantages of the availability of cheap base load electricity.

Pap World Energy Conf, 8th, Trans, Bucharest, Rom, Jun 28-Jul 2 1971 v 6, pap 3.4-210, 9 p. Available from Rom Natl Comm of the World Energy Conf, Bucharest, 1972.

CORROSION OF METALS IN GEOTHERMAL POWER PLANTS. Tskhviraashvili, D. (Inst. of Energy, Tbilisi, USSR); Vardigorelli, O.; Acolisa, P. Geothermics; 1: No. 3, 113-118(Sep 1972).

Experimental research is reported on corrosion of metals and alloys in waters of various springs that differ in temperature and output as well as chemical composition. Tests were carried out on natural thermal waters both at the head of boreholes and in the laboratories. For the first time a dependence was established between the corrosion rate of metals and the velocity of thermal water, the pH value, the temperature, the concentration of atmospheric oxygen in the thermal water. "Waiting time," i.e. the period of time that must elapse before corrosion begins in heating systems by geothermal fluids, was determined. A method of reducing corrosion in this type of heating is that of creating a vacuum in the thermal waters accompanied by their treatment with corrosion inhibitors. Corrosion of carbon steel due to thermal waters containing H₂S and CO₂ can now be prevented in a cheap and reliable way. (auth)

MICROEARTHQUAKES: PROSPECTING TOOL AND POSSIBLE HAZARD IN THE DEVELOPMENT OF GEOTHERMAL RESOURCES. Ward, P. L. (Lamont-Doherty Geological Observatory, Palisades, NY). Geothermics; 1: No. 1, 3-12 (Mar 1972).

Microearthquakes have been observed near many major geothermal areas around the world. Where detailed data are available, there is a close spatial relationship between microearthquakes and geothermal activity. Earthquakes with magnitudes greater than about 4.5, however, are rarely observed in geothermal areas. Locations of microearthquakes can be used to locate active faults that may channel hot water toward the surface. Earthquakes provide some risk in the development of geothermal regions since during an earthquake the flow of thermal fluid can be enhanced or slowed and structures can be damaged. Modification of reservoir fluid pressure may influence the earthquake activity. (auth)

THERMAL PROBLEMS IN THE SITING OF REINJECTION WELLS. Bodvarsson, G. (Oregon State Univ., Corvallis). Geothermics; 1: No. 2, 63-68(Jun 1972).

A theoretical discussion is presented of the thermal problems involved in the disposal of flash water from geothermal power plants by reinjection. The basic equations for the subsurface temperature field in the reinjection zone are derived both for rocks with intergranular and fracture flow. The extent of the thermal contamination by the reinjected water is discussed. In the case of a continuous mass flow of flash water of 1000 kg/sec for a period of 25 years, the contamination may reach out to as much as 5 km or more from the point of re-entry, depending on the type of rock involved. (auth)

1972

RESISTIVITY STUDIES ON THE IMPERIAL VALLEY GEOTHERMAL AREA, CALIFORNIA. Meliav, T. (Univ. of California, Riverside); Furgerson, R. Geothermics; 1: No. 2, 47-62(Jun 1972).

Electrical resistivity was employed for mapping the Imperial Valley of California as part of a multi-disciplinary approach to assess its geothermal potential. Vertical and lateral resistivity changes were determined from Schlumberger depth soundings with effective probing depths up to 8000 ft. Known geothermal anomalies appear as residual resistivity lows superimposed on the regional gradient that decreases northwestward from the southeast corner of the Imperial Valley, near the Colorado River, to values about two orders of magnitude lower at the Salton Sea. A regional salinity gradient in the Imperial Valley trends north-west from a very low salinity at the Colorado River near Yuma, Arizona, to a very high salinity at the Salton Sea geothermal field. Abrupt changes in salinity exist across the Imperial fault, with salinities being much higher west of the fault. Maximum salinities can be estimated by combining the ground resistivity survey and formation factor-depth relationships compiled from well logs. From a technical point of view, the apparent-resistivity and longitudinal-resistivity maps are nearly identical at a probing depth of 3000 ft. Hence continuous profiling at a Schlumberger AB/2 spacing of 3000 ft should permit an effective, low-cost reconnaissance method for still-unsurveyed areas of the Imperial Valley. (auth)

EXERGY OF THERMAL WATER. Bodvarsson, G.; Eggers, D. E. (Oregon State Univ., Corvallis). Geothermics; 1: No. 3, 93-95(Sep 1972).

The exergy of a substance is the theoretical amount of mechanical work that can be derived from its heat content at given initial and end conditions. At given end conditions, the exergy is a state variable. The exergy per unit mass of pure water has been tabulated for the most important initial and end temperatures. An example showing the exergy flux in geothermal power plants is given. (auth)

CEMENTING MATERIALS FOR GEOTHERMAL WELLS. Radenti, G.; Ghiringhelli, L. (AGIP Direzione Minieraria, San Donato Milanese, Italy). Geothermics; 1: No. 3, 119-123(Sep 1972).

In a well used in the search for endogenous fluids the opportunity exists to stop level of thermal waters of high temperature and pressure so that deeper levels can be reached, where it is inferred that there are fluids with better thermodynamic characteristics. The AGIP Laboratories have carried out tests on mortars assumed to be suitable for the clogging of the bedrocks containing the undesired waters. (auth)

1972

PHYSICAL MODEL OF PLANETARY MAGMATISM. Kadik, A. A.; Yaroshevski, A. A. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Geothermics; 1: No. 3, 124-131(Sep 1972).

The convective instability of magma liquids under physical conditions of the gravitational and geothermal fields of the Earth leads to radial transfer of heat and mass in the magma body. This transfer causes crystallization at the bottom and loss of volatiles at the top. As a result the magmatic mass rises towards the Earth's surface by a process similar to zone melting. A physico-chemical theory was developed in which the origin of melt, its rising, and its chemical differentiation are closely related processes. Formed by a partial or complete melting of primary deep material the magma interacts with the country rocks by melting and assimilation. Its composition changes according to the zone melting conditions and the magma floats upward. The extent of the process and the depth at which the movement degenerates depend on the quantity of heat in the magmatic system during its formation. (auth)

SOME CONSIDERATIONS ON THE FLOW-RATE/PRESSURE CURVE OF THE STEAM WELLS OF LARDERELLO. Rumi, O. (Politecnico, Milan). Geothermics; 1: No. 1, 13-24 (Mar 1972).

The flow-rate/pressure relation for the wells of the Larderello area is considered. After an examination of experimental results recorded for many years, and after the discussion of the experimental flow-rate/pressure curve, an attempt is made to find the theoretic link between pressure and flow rate at the mouth of the borehole. The results of the experimental and theoretical approach are then compared, and a best fit curve is proposed. Moreover, the flow-rate/well bottom pressure curve as the true characteristic of the whole system of flow is suggested. (auth)

HEAT FLOW NEAR ORLANDO, FLORIDA AND ULVAIDE, TEXAS DETERMINED FROM WELL CUTTINGS. King, W.; Simmons, G. (Massachusetts Inst. of Tech., Cambridge). Geothermics; 1: No. 4, 133-140(Dec 1972).

Heat flow was determined in a borehole near Orlando, Florida and another near Uvalde, Texas. Thermal conductivities in both boreholes were obtained by divided-bar measurements on rock discs and by needle-probe measurements on rock chips. For the needle-probe method, the rock chips were pulverized into powder, saturated with water, and the conductivity of the solid rock was obtained from the conductivity of the mixture by an empirical relationship. Divided-bar measurements for the Florida borehole indicate a heat flow of $0.92 \pm .03$ H.F.U., while needle-probe measurements on rock chips show a heat flow of $1.24 \pm .06$ H.F.U. The discrepancy is attributed to anisotropy of the sedimentary rocks penetrated by the borehole. Heat flow obtained from these two different methods of determining conductivity show good agreement in the Texas borehole. Divided-bar measurements indicate a heat flow of $1.08 \pm .03$ H.F.U., while the chip technique gives a value of $1.13 \pm .03$ H.F.U. (auth)

N74-20816# Interior Dept., Washington, D.C.
FINAL ENVIRONMENTAL STATEMENT FOR THE GEOTHERMAL LEASING PROGRAM. VOLUME 1: PROMULGATION OF LEASING AND OPERATING REGULATIONS
1973 485 p refs 4 Vol.
Avail: SOD HC \$4.20

Public lands potentially available for geothermal leasing are described. These include principally: (1) public, withdrawn, and acquired lands administered by the Secretary of the Interior; (2) national forests and other lands administered by the Forest Service, Department of Agriculture; and (3) lands containing a reservation to the United States of the geothermal resources. These lands total 638 million acres. The most promising geothermal resource areas are located predominantly in the 11 western States and Alaska. Included in this proposed action are: (1) the promulgation of leasing and operating regulations pursuant to which the program would be administered; and (2) the leasing of federally owned geothermal resources for development in three specific areas: (a) Clear Lake-Geysers; (b) Mono Lake-Long Valley; and (c) Imperial Valley, all in California.

N74-19976# Interior Dept., Washington, D.C.
FINAL ENVIRONMENTAL STATEMENT FOR THE GEOTHERMAL LEASING PROGRAM. VOLUME 3: PROPOSED GEOTHERMAL LEASING AND OPERATING REGULATIONS

1973 697 p refs 4 Vol.
Avail: SOD HC \$5.60

Proposed leasing and operating regulations to implement the Geothermal Steam Act are presented. Included are a study comparing vapor dominated hydrothermal systems with hot water systems, and a classification of public lands valuable for geothermal steam and associated geothermal resources. G.G.

N74-19975# Interior Dept., Washington, D.C.
FINAL ENVIRONMENTAL STATEMENT FOR THE GEOTHERMAL LEASING PROGRAM. VOLUME 2: LEASING OF GEOTHERMAL RESOURCES IN THREE CALIFORNIA AREAS

1973 517 p refs 4 Vol.
Avail: SOD HC \$5.85

Individual environmental statements are presented for the leasing of federally owned geothermal resources for development in three specific areas: (1) Clear Lake geysers; (2) Mono Lake-Long Valley; and (3) Imperial Valley. Also included is a summary of comments and responses relative to the draft environmental impact statement issued in 1971.

Author

N74-19977# Interior Dept., Washington, D.C.
FINAL ENVIRONMENTAL STATEMENT FOR THE GEOTHERMAL LEASING PROGRAM. VOLUME 4: COMMENTS ON DRAFT IMPACT STATEMENT AND PROPOSED REGULATIONS

1973 726 p refs 4 Vol.
Avail: SOD HC \$5.65

Comments received from Federal, State, local, and individual interests on the leasing and operating regulations, the draft environmental impact statement for the Geothermal Leasing Program, and the supplement to the draft statement are presented.

Author

FLOW IN GEOTHERMAL WELLS (AN ANALYTICAL STUDY). Tolivia, E. (Comision Federal de Electricidad, Mexico City). Geothermics; 1: No. 4, 141-145 (Dec 1972).

The flow pattern in geothermal wells was determined from several flow, pressure, and temperature measurements in flowing wells. The procedure followed for the determination of the two-phase flow composition and the flow pattern is shown. A model is proposed for the mechanics of scale formation in the production casing of the wells, caused mainly by the silica-saturated fluid produced. The flow pattern for horizontal pipelines and the calculation for the pressure gradient using Dukler equations are presented. The calculated values are then compared with experimental values obtained in a 674-meter-long pipeline discharging a steam-water mixture. (auth)

(LA-DC-72-669) INDUCTION AND GROWTH OF FRACTURES IN HOT ROCK: ARTIFICIAL GEOTHERMAL RESERVOIRS. Aamodt, R. Lee; Smith, Morton C. (Los Alamos Scientific Lab., N. Mex.). 1972. 31p. (CONF-720607-23). Dep. NTIS.

From eighteenth annual American Nuclear Society conference; Las Vegas, NV. (18 Jun 1972).

TITLE: Geothermal Power
AUTHOR: Barnea, J.
CORPORATE AUTHOR: United Nations, Resources and Transport Div.

ADDRESS: New York, NY
PUBLICATION DESCRIPTION: Scientific American, 226(1), 70-77

PUBLICATION DATE: 1972, January
ABSTRACT: Geothermal fields can provide other useful products in addition to electric power. Possible applications include: desalting seawater; heating homes, greenhouses, and swimming pools; and providing non-electrical energy for refrigeration and air conditioning. The three classes of usable geothermal energy sources are dry steam fields, wet steam fields, and fields of lesser heat content. The use of each type of field is described, and costs for developing geothermal power are estimated. The paramount need is to develop exploratory techniques to locate geothermal reservoirs. (NPG)

CN-129, 707

N74-16670# Committee on Interior and Insular Affairs (U. S. Senate).

GEOTHERMAL ENERGY RESOURCES AND RESEARCH Washington GPO 1972 472 p refs Hearings before Comm. on Interior and Insular Affairs, 92d Congr., 2d Sess., 15 and 22 Jun 1972

Avail: SOD HC \$2.75

A Congressional hearing was conducted to discuss the role of geothermal energy resources in the nation's economy. The proposed costs of research and development projects for geothermal energy exploitation are discussed. The research projects to be conducted are defined. Information is provided on the subjects of: (1) assessment of geothermal energy resources, (2) a theoretical study of geothermal energy extraction, (3) classification of public lands valuable geothermal steam and associated geothermal resources, and (4) environmental impact statement for the geothermal leasing program.

TITLE: Geothermal Energy - Growth Spurred on by 'Powerful Motives'

AUTHOR: Chasteen, A.J.

CORPORATE AUTHOR: Union Oil Co., Geothermal Division

ADDRESS: Big Geysers, CA

PUBLICATION DESCRIPTION: Mining Engineering, 24(10), 101-102

PUBLICATION DATE: 1972, October

ABSTRACT: This article reviews the prospects for geothermal power development, particularly in the U.S. Geothermal resources, drilling for steam wells, and special problems associated with a geothermal power plant are discussed. Experience with the Geysers geothermal system is reviewed, and the domestic outlook for geothermal energy is discussed. (NPG)

GEOTHERMAL ENERGY IN MEXICO: EXPLORATION AND UTILIZATION. Geiza, J.; Mercado, S. (Comision Federal de Electricidad, Mexico City). pp 183-189 of III Interamerican Conference on Materials Technology. Buenos Aires; Centro Regional de Ayuda Tecnica (1972). (In Spanish).

From 3rd Inter-American conference on materials technology; Rio de Janeiro, Brazil (14 Aug 1972). See CONF-720832.

Geothermal heat is the "new" energy that has attracted the attention of Mexican scientists, technologists, and economists who have undertaken its harnessing. Mexico has two principal geothermal systems (north and central) with more than a hundred classified thermal centers. Under development is the Cerro Prieto field which plans on a plant of 75 MW being programmed for an immediate increase to 150 MW. Being explored are the following etc. The principal use of such energy will be in the generation of electricity, with decreasing fossil-fuel consumption and less environmental pollution. 11 figures. (auth)

1972

1972

PB-208 954 PC33.00/MF\$0.95
Department of the Interior, Washington, D.C.
GEOTHERMAL LEASING PROGRAM.
3 May 72, 1973* ELR-4360, DES-72-54
Supplement to Draft dated 6 Oct 71, PB-203 102-D.

Descriptors: (*Environmental surveys, *Geothermal prospecting), (*Electric power generation, *Fuels), Leasing, Government policies, Coal, Manufactured gas, Petroleum products, Fossil fuels, Nuclear electric power generation, Shale oil, Bituminous sands, Hydroelectric power generation, Regulations.
Identifiers: *Environmental impact statements.

The document contains the following: A revised draft of the section on Alternatives to Proposed Action originally issued as part of the Draft Environmental Impact Statement for the Geothermal Leasing Program dated September 1971; Energy alternatives, to the Draft Environmental Impact Statement discussing alternative sources of energy in the event the leasing program is not implemented, and Proposed unit plan regulations for geothermal steam and associated geothermal resources. (Author)

N74-15661# Interior Dept., Washington, D.C.
ASSESSMENT OF GEOTHERMAL ENERGY RESOURCES
Dallas L. Peck 25 Sep. 1972 86 p refs
Avail: NTIS HC \$6.50 CSCL 20M

A study was conducted to develop and assessment of the state of the art and to recommend a research program to provide the basis for establishing the proper role of geothermal resources. It is expected that geothermal resources can accomplish the following: (1) provide additional energy to alleviate the Nation's impending storage, (2) water to supplement present supplies, and (3) mineral resources. It was recommended that an expanded program be conducted to assess the magnitude, type, and location of the Nation's geothermal resources and to spur the development of improved technology for discovering, evaluating, and utilizing the resources. The significant accomplishments to be realized by such a program are defined. Author

HEAT TRANSFER: THE GEYSERS GEOTHERMAL POWER PLANT.
J.P. Finney.

Chemical Engineering Progress v68. no.7 July 1972
pp. 83-86.

A JOINT VENTURE TO TAP THE EARTH'S HEAT.
Business Week, Nov.11,1972, p.53.

GEOTHERMAL ENERGY: AN EMERGING MAJOR RESOURCE.
A.L. Hammond.
Science, v.177, Sept.15,1972, p.978-980.

Three types of resources are being considered—
steam, hot water, and hot rock.

GEYSERS GEOTHERMAL POWER PLANT. Finney, J. P. (Pacific Gas and Electric Co., San Francisco). Chem. Eng. Progr.: 68: No. 7, 83-86(Jul 1972).

The generation of electric power has proven commercially successful at the Geysers. Power production costs there compare favorably with those of PG&E's latest supercritical fossil units. Attention to design, operation, and maintenance have overcome problems associated with particulate matter in the steam and the corrosiveness of the condensate. Additional generating capacity is scheduled each year through 1974, at which time it will total 802,000 kW, making the Geysers power plant the largest geothermal power installation in the world. Capacity will continue to be installed as additional steam reserves are developed. (auth)

PB-224 882/1GA PC33.75/MF\$1.45
Federal Council for Science and Technology.
Washington, D.C. Committee on Energy Research and Development Goals.
ASSESSMENT OF GEOTHERMAL ENERGY RESOURCES.
Dallas L. Peck. 26 Jun 72, 97p*

Descriptors: (*Geothermal prospecting, *Electric power generation), Reviews, Utilization, Natural resources, Geology, Research projects, Recommendations.
Identifiers: *Geothermal energy, Technology assessment.

An extensive assessment of the state of the art of geothermal energy is presented and recommendations made for research and development on the federal level. Included are summaries of current research by various government agencies and private industry.

TITLE: A Theoretical Study of Geothermal Energy Extraction
AUTHOR: Harlow, P.H.; Pracht, W.P.
CORPORATE AUTHOR: Los Alamos Scientific Laboratory, Group T-3, Theoretical Division
ADDRESS: Los Alamos, NM 87544
PUBLICATION DESCRIPTION: Report WC. LA-DC-72-158, reprinted in Committee Print Serial No. 92-11, Geothermal Energy Resources and Research, Hearings on The Role of Geothermal Energy Resources in Our Nation's Future Energy Economy, p. 269-307
PUBLICATION DATE: 1972
SPONSOR: U.S. Atomic Energy Commission
ABSTRACT: Efficient extraction of geothermal energy from a dry well depends upon the ability to establish a closed, pressurized circuit of water through a large zone that has been fractured in hot impermeable rock. Long-term perpetuation of significant power extraction depends in addition on the ability to extend the initial fracture zone through the effects of thermal-stress cracking of the adjacent hot rocks. In support of an experimental program to test the feasibility of utilizing this type of energy source, we have solved numerically the coupled equations that described the coupled processes of fluid flow, heat transport and rock fracture. The results show a strong dependence on the extent to which underground pressure can be maintained and the fracture zone continuously extended. They indicate that under favorable (but perhaps not unreasonably exotic) circumstances, the extraction of significant thermal power from each well can be expected to continue for many decades. (Auth)

AVAILABILITY: Part of "Geothermal Energy Resources and Research", GPO, Stock No. 5270-01633, (\$2.75)

N74-15776# Informatics, Inc., Rockville, Md.
SOVIET GEOTHERMAL ELECTRIC POWER ENGINEERING, REPORT 2
V. A. Serevich, Dec. 1972 85 p refs
(Contract F44620-72-C-0053; ARPA Order 1622-3) (AD-754947; AFOSR-73-0034TR) Avail: NTIS CSCL 10/2
Information is provided on Soviet geothermal research and engineering associated with the design, construction, and maintenance of geothermal power plants and related facilities. Besides a general outline of geothermal characteristics, emphasis in this report is on Soviet geothermal research and development, including engineering data on existing power plants, as well as those under construction and in the planning stages. Other actual and potential applications of geothermal water such as for space heating, hotwater supply, mining and construction in permafrost regions, refrigeration, air conditioning, agriculture, medical and health applications, etc., are discussed.
Author (GRA)

A73-16382 A theoretical study of geothermal energy extraction. F. H. Harlow and W. E. Pracht (California, University, Los Alamos, N. Mex.). *Journal of Geophysical Research*, vol. 77, Dec. 10, 1972, p. 7038-7048, 7 refs. AEC-sponsored research.
Efficient extraction of geothermal energy from a dry well depends on the ability to establish a closed pressurized circuit of water through a large zone fractured in hot impermeable rock. Long-term perpetuation of significant power extraction depends, in addition, on the ability to extend the initial fracture zone through support of an experimental program to test the feasibility using this type of energy source, the combined equations describing the coupled processes of fluid flow, heat transport, and rock fracture were solved numerically. The results show a strong dependence on the extent to which underground pressure can be maintained and the fracture zone continuously extended. They indicate that under favorable, but perhaps not unreasonably exotic, circumstances the extraction of significant thermal power from each well can be expected to continue for many decades. (Author)

UNWE-SV-4259(Rev.10DR) PLOWSHIRE STIMULATED LATEX OF GEOTHERMAL SYSTEMS. Stewart, D. H.; Burnham, J. (Battelle Pacific Northwest Labs., Richland, Wash.). Int. J. Geotherm. (CONF-720417-2). Dep. NTIS \$3.00.
From Conference on nuclear power for tomorrow, Atlantic City, New Jersey, USA (22 Aug 1972).
The economics and feasibility of using nuclear explosions for recovering geothermal energy from natural and dry hot rock sources are reviewed. (TFD)

TITLE: Geothermal Energy - The Neglected Energy Option
AUTHOR: Rex, R.W.
CORPORATE AUTHOR: California, University of, Riverside, Geothermal Resources Program
ADDRESS: Riverside, CA
PUBLICATION DESCRIPTION: Part of Lewis, R.G. (Ed.), Spinrad, B.I. (Ed.), "The Energy Crisis", Educational Foundation for Nuclear Science, Chicago, IL, 148 p. (121-125)
PUBLICATION DATE: 1972, July
ABSTRACT: Geothermal energy is clean and cheap and should be seriously considered for electric power generation. Exploration efforts might yield up to one million megawatts within 30 years with savings of over \$100 per kilowatt compared to alternative power generation systems. Geothermal reserves, the possibilities of developing this resource for power generation, the use of dry steam fields and hot water fields, and research efforts in geothermal energy are reviewed in this paper. (MPC)

74N72432 72/01/00 97 PAGES UNCLASSIFIED DOCUMENT
GEOTHERMAL RESOURCE INVESTIGATIONS IMPERIAL VALLEY, CALIFORNIA.
DEVELOPMENTAL CONCEPTS
BUREAU OF RECLAMATION, DENVER, CCLC. AVAIL. NTIS
SPONSORED BY INTERIOR DEPT.
/*ENERGY SOURCES/*GEOTHERMAL ENERGY CONVERSION/ CALIFORNIA/
IMPERIAL VALLEY (CA)

73V16704 1973 ISS 00 TK1041.G4 C-804708-22-3 333.7 LC-72-85700
GEOTHERMAL ENERGY: RESOURCES, PRODUCTION, STIMULATION. EDITED BY
PAUL KRUGER AND CAREL CITE.
STANFORD UNIVERSITY PRESS, STANFORD, CALIF.; X; 360 P. ILLUS. 24 CM.
\$17.50 BASED ON PAPERS PRESENTED AT THE SPECIAL SESSION CN
GEOTHERMAL ENERGY HELD AT THE AMERICAN NUCLEAR SOCIETY ANNUAL MEETING,
JUNE 19-20, 1972, IN LAS VEGAS, NEV. INCLUDES BIBLIOGRAPHIES.
LC GEOTHERMAL ENGINEERING -- CONGRESSES. ELECTRIC POWER-PLANTS --
CONGRESSES. GEOTHERMAL RESOURCES -- CONGRESSES.
ADDED KRUGER, PAUL, 1922- ED. CITE, CAREL, 1922- ED. AMERICAN
NUCLEAR SOCIETY.
MAIN-TITL TRACE-CORP*AUTH# CATLG BY-LC

74N71342 73/04/00 12 PAGES UNCLASSIFIED DOCUMENT
GEOTHERMAL POWER PROJECT OF PACIFIC GAS AND ELECTRIC COMPANY AT THE
GEYSERS, CALIFORNIA
A/FINNEY, J. P.; B/MILLER, F. J.; C/MILLS, D. B. AVAIL. NTIS
PACIFIC GAS AND ELECTRIC CO., SAN FRANCISCO, CALIF. SCC., JUL.
PRESENTED AT SUMMER MEETING OF THE IEEE POWER ENG. JUL.
1972
/*GEOTHERMAL ENERGY CONVERSION/*GEYSERS/*TURBOGENERATORS/
CALIFORNIA/ COST ESTIMATES/ HYDROGEN SULFIDE/ STEAM

74V11282 1972 ISS 00 TK1041.G42 1972 333.8 LC-73-621555
 GEOTHERMAL ENERGY A NATIONAL PROPOSAL FOR GEOTHERMAL RESOURCES
 RESEARCH; FINAL REPORT. CHAIRMAN WALTER J. HICKEL. EDITOR JESSE C.
 DENION.
 GEOTHERMAL RESOURCES RESEARCH CONFERENCE, BATTELLE SEATTLE RESEARCH
 CENTER. 1972.
 UNIVERSITY OF ALASKA SEATTLE VI, 95 P. 28 CM.
 THE CONFERENCE WAS SPONSORED BY THE NATIONAL SCIENCE FOUNDATION.
 BIBLIOGRAPHY P. 78-88.
 LC GEOTHERMAL ENGINEERING. GEOTHERMAL RESOURCES. STEAM POWER-PLANTS.
 ADDED HICKEL, WALTER J., 1919- DENICN, JESSE C., ED. UNITED STATES.
 NATIONAL SCIENCE FOUNDATION.
 MAIN-MEET TRACE-CORP*ITIL*AUTH* CATLG BY-LC

1972

TITLE: Geothermal Energy, A National Proposal for
 Geothermal Resources Research

AUTHOR: Hickel, W.J.

CORPORATE AUTHOR: University of Alaska

ADDRESS: College, AK 99701

PUBLICATION DESCRIPTION: Report No.

NSF/RANN-73-003, PB-222 326, Final report of
 the Geothermal Resources Research Conference,
 Battelle Seattle Research Center, Seattle,
 Washington, September 18-20, 1972, 95 p., 11
 p. of references

PUBLICATION DATE: 1972

SPONSOR: National Science Foundation, RANN Program

ABSTRACT: This report presents the results of the

Geothermal Resources Research Conference held

in September, 1972. The importance of

geothermal resources to the nation is

discussed first, followed by budget

recommendations for research on geothermal

resources and an overview of geothermal

resources. Reports of the six conference

panels are included: Resource Exploration;

Resource Assessment; Reservoir Development

and Production; Utilization Technology and

Economics; Environmental Effects; and

Institutional Considerations. The report

concludes with a summary of research needs

and an extensive bibliography. (HFO)

AVAILABILITY: NTIS (\$8.65)

1972

1971

TITLE: Power from the Earth: Geothermal Energy
AUTHOR: Tappin, D.C. (Compiler)
CORPORATE AUTHOR: University of California, Berkeley, Institute of Governmental Studies
ADDRESS: Berkeley, CA
PUBLICATION DESCRIPTION: Public Policy Bibliographies: 3, 38 p.
PUBLICATION DATE: 1972, September
ABSTRACT: This bibliography covers publications since 1965 on geothermal energy in the United States and public administration, water resources, engineering, and earth sciences relating to geothermal energy. Separate sections are devoted to geothermal energy in nine states and Federal geothermal programs including the Plowshare program. The bibliography contains 266 citations and an index. (MPC)
AVAILABILITY: Institute of Governmental Studies, University of California, Berkeley, CA (92-50)

N74-16049# Geological Survey, Washington, D.C.
CLASSIFICATION OF PUBLIC LANDS VALUABLE FOR GEOTHERMAL STEAM AND ASSOCIATED GEOTHERMAL RESOURCES

L. H. Godwin, L. B. Haigler, R. L. Rioux, D. E. White, L. J. P. Muffler, and R. G. Wayland 1971 21 p refs
(CIRC-647) Avail: NTIS HC \$3.25

The classification standards for determining which Federal lands are classifiable as geothermal steam and associated geothermal resources lands under the Geothermal Steam Act of 1970 (84 Stat. 1566) are presented. The concept of a geothermal resources province is established for classification of lands for the purpose of retention in Federal ownership of rights to geothermal resources upon disposal of Federal lands. A geothermal resources province is defined as an area in which higher than normal temperatures are likely to occur with depth and in which there is a reasonable possibility of finding reservoir rocks that will yield steam or heated fluids to wells. The determination of a known geothermal resources area is made after careful evaluation of the available geologic, geochemical, and geophysical data and any evidence derived from nearby discoveries, competitive interests, and other indicia. Author

(BNWL-B-110) FOREIGN AND DOMESTIC DISCUSSIONS ON NATURAL GEOTHERMAL POWER AND POTENTIAL USE OF PLOWSHARE TO STIMULATE THESE NATURAL SYSTEMS. Burnham, J. B.; Stewart, D. H. (Batelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 6 Jul 1971. 19p. Dep. NTIS.

A survey of the major geothermal areas of the world was conducted during May 1971. Visits were made to California, Australia, Hawaii, Iceland, Italy, and New Zealand to obtain first hand information from geothermal plant geologists, drillers, and plant operators and to discuss a proposed USAEC Plowshare Geothermal Stimulation research program. A summary is given of the geothermal resources of each country visited and included information on location, geology, production, power plant development, and future plans related to geothermal energy. (L.C.I.)

GEOTHERMAL HOT WATER RECOVERY PROCESS AND SYSTEM. Kuwada, J. T. (to Rogers Engineering Co., Inc.). US Patent 3,782,468. 1 Jan 1974. Filed date 20 Sep 1971. 14p.

An improved process and system for recovering high-temperature hot water from a geothermal supply is described. Equipment is described for reducing the pressure at the well head, flashing the hot water to steam to elevate a two-phase mixture of steam and hot water through the casing assembly. Such flashing is accompanied by the evolution of substantially non-condensable gases, including carbon dioxide, and separated with the steam from the elevated hot water, the latter being withdrawn from the system for its intended use, such as the generation of electric power. The separated steam and gases are heat exchanged to condense the steam and to withdraw useful heat from the gases, and the gases are compressed and recycled into contact with the underground hot water supply to assist in elevating additional hot water. The carbon dioxide-containing gases are effective in countering the problems normally created when geothermal hot water is allowed to flash to steam, namely the formation of system clogging deposits. Thus, without utilizing mechanical or other pumping devices within the well, recovery of a substantially constant stream of geothermal hot water from a deep underground well may be effected. (MCW)

(JPRS-60673, pp 8-15) WAYS SOUGHT TO TAP EARTH'S INTERNAL HEAT. 3 Dec 1973. Translated From K'o Hsueh Shih Yen; No. 6, 33-35(1971). NTIS.

In translations on People's Republic of China, No. 250. The hot springs at Peking's Hsiao-tang-shan, Liaoning's Tang-gang-tau, and Shanxi's Hsiao-ch'ing-ch'ih are famous hot springs of China. In recent years, reports on hot springs from various places have been numerous, and the number of the hot water wells has greatly increased due to tremendous progress accomplished in geology. An extremely rich resource in Earth's heat is kept within the national boundary. Ways to exploit these resources are discussed briefly. (MCW)

GEOTHERMAL: EARTH'S PRIMORDIAL ENERGY. Bowen, R. G.; Groh, E. A. Technol. Rev. 73: 42-48(1971).

Geothermal sources hold the potential for a significant increase in energy sources. The heat supply can only be exploited from the local hot spots—subterranean reservoirs where the heat has accumulated and is stored in the form of steam and hot water. Regions of high heat flow usually display hot springs, geysers, and fumaroles or steam vents. Productive results from exploration at such sites are represented by Larderello in Italy, Wairakei in New Zealand, and at the Geysers of California. Dry steam was reported from a well drilled in Valles Caldera, Sonora Co., New Mexico. Hot brine with temperatures up to 650°F., has been produced at the Salton Sea area in Imperial Valley of southern California, and additional reservoirs are reported and being utilized by Mexico at an extension of the Imperial Valley. Japan and Iceland are using geothermal heating. Hungary and the USSR have reservoirs for development of the utilization of geothermal energy. The economics and environmental impact are discussed. (JCW)

1971

(JPRS-60673, pp 1-7) EXPERIMENTAL GEOTHERMAL POWER STATION. 3 Dec 1973. NTIS.

Saii Yen; No. 6, 36-37(1971). NTIS.

In translations on People's Republic of China, No. 250.

A geothermal power station was built at Feng-shun Hsien of Kwangtung Province. The geothermal shaft is 800.81 meters in depth, and the water temperature at the well bottom is 103.5°C and at the opening 91°C. The water head's absolute pressure is 1.65 kg/mm² and the geothermal artesian flow rate is 80 tons/hour. The thermal power system of this experimental power station is primarily composed of the degasser, volume expander, steam turbine, condenser, gas pump, and four water pumps. Hot water is introduced from the geothermal well opening to a relatively low-pressure container (expansion container), where part of the hot water is vaporized to produce steam to push the steam turbine and the generator to generate electricity. The rubber axle seal (tight seal at the bearings) and the water ejection pump were used to solve the problems concerning the steam turbine's axle seal and pump. The air pressure is reduced, the system's equipment is simplified, and fuel is no longer necessary. The thermal power system of the experimental station is shown. (auth)

TITLE: Geothermal Science and Technology. I

National Program

AUTHOR: Austin, C.F.; Austin, R.N., Jr.; Leonard,

G.W.

CORPORATE AUTHOR: U.S. Dept. of Defense, Naval

Weapons Center

ADDPSS: China Lake, CA

PUBLICATION DESCRIPTION: Report No. 45-029-72,

reprinted in Committee Print Serial No.

92-31, Geothermal Energy Resources and

Research, Hearings on the Role of Geothermal

Energy Resources in Our Nation's Future

Energy Economy, P. 341-461

PUBLICATION DATE: 1971, September

ABSTRACT: The major portion of the geothermal

prospect called the Casa Thermal Area lies within the instrumented test range of the Naval Weapons Center, China Lake, Calif. In developing plans for scientific utilization of the Casa Thermal Area, the state-of-the-art of geothermal science and technology was reviewed. The review indicated that the development of geothermal deposits for the purpose of generating electricity, providing heat, and obtaining raw materials was a technology in its infancy, with critical aspects subject to uncertainty. This study has resulted in a proposal for a national geothermal science and technology advancement program which will be accomplished by gathering scientific and engineering data from five selected sites representing each of the five principal types of geothermal deposits that are known or hypothesized. (auth)

AVAILABILITY: Part of "Geothermal Energy

Resources and Research", GPO, Stock No.

5270-01633, (\$2.75)

1971

TITLE: A Feasibility Study of a Plowshare Geothermal Power Plant
AUTHOR: Chapin, C.R.; Sherwood, D.W.; Contois, W.H.; Walton, P.T.; Stewart, D.H.; Burnham, J.B.

CORPORATE AUTHOR: American Oil Shale Corp.; Battelle, Pacific Northwest Laboratories; Westinghouse Electric Corp.; Lawrence Radiation Laboratory; U.S. Atomic Energy Commission, Nevada Operations Office
PUBLICATION DESCRIPTION: Report No. PNE-1550, 175

PUBLICATION DATE: 1971, April
SPONSOR: American Oil Shale Corp.; U.S. Atomic Energy Commission

ABSTRACT: This study explores the factors involved in using a novel energy source -- the heat in the earth -- to produce electric power. In contrast to drilling for naturally occurring steam, this concept aims toward extracting heat directly from a heat source composed of hot rock. It does not rely on a naturally occurring steam reservoir or circulation system. The basis of the concept is the use of nuclear explosives to fracture large quantities of the hot rock. Heat would be extracted from the fractured region by piping water to it and creating steam that would be used to run a turbine-generator and produce electricity. The system would be closed by recycling the condensed steam from the power plant back to the fractured region.

1971

TITLE: Power From the Earth
AUTHOR: Penner, D.; Kiarassan, J.
CORPORATE AUTHOR: Washington University
ADDRESS: St. Louis, MO
PUBLICATION DESCRIPTION: Environment, 13(10), 19-34

PUBLICATION DATE: 1971, December
ABSTRACT: The present situation of geothermal energy as a means of producing electric power is reviewed. The mechanisms of producing electricity with geothermal energy and the cost of production are discussed in a nontechnical manner. Estimates of world geothermal resources are surveyed. Geothermal energy appears to be relatively pollution free, but hydrogen sulfide and trace chemicals in the geothermal steam could be hazardous. Before large amounts of money are spent in developing geothermal power, the following problem areas should be extensively investigated: the lifetime of the geothermal sources; seismic activity and ground subsidence; air and water pollution from the geothermal steam impurities; effects on the fresh water table of withdrawal of geothermal fluids; and cost analysis to show that geothermal power production will be competitive. Environmental statements should be prepared for public review before extensive development. (KPG)

Z Summers, W K comp.
 5862.2 Annotated and indexed bibliography of
 geothermal phenomena; compiled by W. K.
 W3 Summers. Socorro, N. M., New Mexico
 S86 State Bureau of Mines and Mineral Resources,
 1971.
 586, [79] p. 23 x 29 cm.
 At head of title: New Mexico State
 Bureau of Mines and Mineral Resources.

1970

GEOTHERMAL RESOURCES OF THE NORTHERN
 GULF OF MEXICO BASIN. Jones, P. H. (Geological Survey,
 Baton Rouge, LA). Geothermics; No. Special Issue, 14-26
 (1970).

Published geothermal gradient maps for the northern Gulf
 of Mexico basin indicate little or no potential for the develop-
 ment of geothermal resources. Results of deep drilling from
 4000 to 7000 meters or more during the past decade however,
 define very sharp increases in geothermal gradient that are
 associated with the occurrence of abnormally high interstitial
 fluid pressure. Bounded by regional growth faults along the
 landward margin of the Gulf Basin, the geopressured zone ex-
 tends some 1300 km from the Rio Grande to the mouth of the
 Mississippi River. Gulfward, it extends to an unknown distance
 across the Continental Shelf. Within geopressured deposits,
 geothermal gradients range upwards to 100°C/km, being greatest
 within and immediately below the depth interval in which the
 maximum pressure gradient change occurs. The 120°C isogeo-
 therm ranges from about 2500 to 5000 m below sea level, and
 conforms in a general way with depth of occurrence of the top
 of the geopressured zone. Measured geostatic ratios range
 upward to 0.97; the maximum observed temperature is 273°C.
 at a depth of 5859 m. Dehydration of montmorillonite, which
 comprises 60 to 80% of clay deposited in the Northern Gulf
 Basin during the Neogene, occurs at depths where temper-
 ature exceeds about 80°C, and is generally complete at depths
 where temperature exceeds 120°C. This process converts intra-
 crystalline and bound water to free pore water, the volume
 produced being roughly equivalent to half the volume of mont-
 morillonite so altered. Produced water is fresh, and has low
 viscosity and density. Sand-bed aquifers of deltaic, longshore,
 or marine origin form excellent avenues for drainage of geo-
 pressured deposits by wells, each of which may yield 10,000 m³
 or more of superheated water per day from reservoirs having
 pressures up to 1000 bars at depths greater than 5000 m. (46
 references) (auth)

LC-72-183003

POWER FROM THE EARTH; THE STORY OF THE WAIRAKEI GEOTHERMAL PROJECT.
 2D ED. GOVT. PRINT., WELLINGTON, 39 P. ILLUS., MAPS, PLANS. 20 X
 28 CM.
 COVER-TITLE WAIRAKEI.
 LC WAIRAKEI GEOTHERMAL PROJECT.
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494

1970

(ORNL-TM-3021) PRELIMINARY INVESTIGATION
 DESALTING OF GEOTHERMAL BRINES IN THE IMPERIAL
 VALLEY OF CALIFORNIA. Spiewak, I.; Hise, E. C.; Reed, S. A.;
 Thompson, S. A. (Oak Ridge National Lab., Tenn. (USA)). 4 Mar
 1970. Contract W-7405-eng-26. 46p. Dep. NTIS \$4.50.

The Imperial Valley Project is an applied research program to
 provide geologic, hydrologic, engineering, and economic informa-
 tion necessary for development of the geothermal resources of the
 delta of the lower Colorado River. It is suggested that a desalting
 pilot plant be associated with the project to develop an economic
 desalting process if 2 to 3% geothermal brine is produced. The pro-
 cess will be unconventional in that waste heat must be rejected to
 atmosphere in wet or dry cooling towers. The presence of large
 amounts of CO₂, H₂S, and silica will require gas removal and silica-
 scale control equipment. The plant would process up to 75,000 gal-
 lons of brine per day. (MCW)

(ORNL-TM-3021) PRELIMINARY INVESTIGATION
 DESALTING OF GEOTHERMAL BRINES IN THE IMPERIAL
 VALLEY OF CALIFORNIA. Spiewak, I.; Hise, E. C.; Reed, S. A.;
 Thompson, S. A. (Oak Ridge National Lab., Tenn. (USA)). 4 Mar
 1970. Contract W-7405-eng-26. 46p. Dep. NTIS \$4.50.

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 cess will be unconventional in that waste heat must be rejected to
 atmosphere in wet or dry cooling towers. The presence of large
 amounts of CO₂, H₂S, and silica will require gas removal and silica-
 scale control equipment. The plant would process up to 75,000 gal-
 lons of brine per day. (MCW)

73V22864 1970 ISS OG TK1322.6.W35P68 1970 621.3121320993122

HYDRODYNAMICS OF GEOPRESSURE IN THE NORTH-EASTERN GULF OF MEXICO BASIN. Jones, P. H. (Geological Survey, Baton Rouge, LA). J. Petrol. Technol., 803-810 (Jul 1969).

An attempt is made to explain the phenomena of compaction and compaction and the resistance to fluid expulsion associated with geopressure in Miocene and Pliocene deposits of the northern Gulf of Mexico Basin. Deltic sediments and their prodelta and neritic equivalents were rapidly deposited and deeply buried. The montmorillonite content of these deposits ranged from about 50 to 80 percent or more. Contemporaneous faults compartmentalized sand-bed aquifers prior to escape of their interstitial saline water. Fluid pressure in compartmentalized reservoirs increased with deepening burial. Salinity of aquifer water increased where hyperfiltration by semipermeable clay beds concentrated dissolved solids in zones of water loss. Heating of the deposits accompanied deepening burial. Thermal dehydration of montmorillonite in a depth-related temperature zone with an average temperature of 221°F released some intracrystalline water as free pore water. Diagenesis of dehydrated montmorillonite (alteration to illite or chlorite) released remaining intracrystalline water. Dehydration and diagenesis of montmorillonite produced interstitial fresh water, markedly increasing effective porosity and permeability to fresh water, while markedly reducing the bulk density. Water flow upward from geopressured zones through clay beds in which dehydration and diagenesis of montmorillonite had occurred was accompanied by interstitial precipitation of cementing solids in the upper part of the clay bed, while the lower part of the same bed remained undercompacted and very soft to the drill. (42 references.) (MCW)

(UCRL-Trans-10726) FIRST GEOTHERMAL POWER STATIONS. Vymortov, B. M. Translated from Vestr. Akad. Nauk SSSR, No. 10, 32-38(1965). 23p. Dep. NTIS \$3.25.

A description of the first geothermal power station in Kamchatka-Pauzhetskaya is given. Stations are to be built at Bol'she-Bannaya, Yuzhno-Kuril'skaya, and Zhirovskaya. The resources of the thermal waters at each plant, construction plans, and power output are discussed. Total power output for the four stations under review will be 6000 to 12,000 kW and can be regarded as belonging to the low-power class. They do not solve the power crisis for the region. (MCW)

G. SOLAR

The Courier

January 1974 Number 1

POWER FROM THE SUN

By Harry Lustig

4 OUR Dwindling ENERGY RESOURCES

6 THE BIG FIVE OF WORLD ENERGY

Coal, petroleum, natural gas, uranium, hydro-power

14 UNESCO AND THE CHANGING ATTITUDE TOWARD SOLAR ENERGY

By Rolf E. Glitsch

16 POWER FROM THE SUN

By Peter E. Glasz

21 DOWN ON THE SOLAR FARM

22 YAMASHITA'S MIRRORS ON A HOT TOKYO ROOF

Photo report

24 SOLAR ENERGY CLAIMS A NEW PLACE IN THE SUN

By Dan Behrman

26 HOME SWEET SOLAR HOME

Photo report

28 THE WELL OF KNOWLEDGE

How a school's solar pump transformed a Mauritanian oasis

By Howard Brabyn

30 AFRICA PLUGS IN TO THE SUN

Photo report

33 HUNTING THE SUN IN THE STEPPES OF CENTRAL ASIA

By Vadim Orlov

SOLAR ENERGY—HOW SOON?

Egan O'Connor.

Chemtech, May 1974, p.264-267.

The solar energy plantation, evaluated in these pages, is becoming reality. They have booked a design contract for two federal installations and proposals are nearing completion for two private firms.

TITLE: Recommendations to RANW/RSP - Solar Energy RST Program

AUTHOR: Greeley, R.S. (Compiler)

CORPORATE AUTHOR: Mitre Corp.

ADDRESS: Westgate Research Park, McLean, VA 22101

PUBLICATION DESCRIPTION: Report No. 874-21, 79 p.

PUBLICATION DATE: 1974, February

SPONSOR: National Science Foundation, RANW Program

ABSTRACT: A systems analysis of solar energy programs was conducted by The MITRE

Corporation and a summary of the results is provided. Briefly, various solar energy

applications and techniques are expected to become economically competitive with

conventionally fueled systems between 1985 and 2000 and, given strong Federal support,

could provide significant quantities of energy to the U. S. early in the 21st

Century. In order to achieve this result, a set of multi-disciplinary research tasks and

proof-of-concept experiments are required to overcome a variety of technical, economic,

environmental, social and institutional problems which currently exist. A five-year

solar energy research and technology program was developed by MITRE and is recommended to

the Research Applied to National Needs program of the National Science Foundation to

carry out these tasks and experiments. The details of the budget for fiscal years

'74-'79 are presented for two levels of effort, a "mainline" and an "accelerated"

program. A "reduced allocation" budget is also presented. The problems associated with

each of seven solar energy applications and techniques are identified and details of

proof-of-concept experiments in each area are outlined. Recommended methods for the

dissemination and utilization of research results are listed. (Auth)

AVAILABLE: Dr. Richard S. Greeley, Mitre Corporation, Westgate Research Park, McLean, VA 22101

HARNESSING NATURE'S ULTIMATE ENERGY SOURCE.

Staff Report.

Optical Spectra, v.8, no.5, May 1974,

p.27-32.

Fusion researchers in laboratories are getting close to answering the feasibility question, and others are taking a new look at our oldest energy source, the sun.

1974

N74-18721*# Georgia Inst. of Tech., Atlanta. School of Mechanical Engineering.
COMPARATIVE EVALUATION OF SOLAR, FISSION, FUSION, AND FOSSIL ENERGY RESOURCES. PART 1: SOLAR ENERGY Final Report
 J. R. Williams 23 Jan. 1974 122 p refs
 (Grant NGR-11-002-166)
 (NASA-CR-137242) Avail: NTIS HC \$9.25 CSCL 10A

The utilization of solar energy to meet the energy needs of the U.S. is discussed. Topics discussed include: availability of solar energy, solar energy collectors, heating for houses and buildings, solar water heater, electric power generation, and ocean thermal power.
 F.O.S.

BREAKING THE SOLAR ENERGY LOGJAM.

J.H. Douglas.

Science News, v.105, Apr.13,1974, p.242-243.

Solar-related energy has been neglected for economic, not technological reasons. New efforts in Congress may help solve this problem.

A SUNNY OUTLOOK FOR SOLAR POWER.

M. Eleccion.

IEEE Spectrum, v.11, no.4, Apr.1974, p.76,77.

At NSF, a fiftyfold increase in funding over four years may presage a bright future for its solar energy program.

N74-18728# Commonwealth Scientific and Industrial Research Organization, Melbourne (Australia). Div. of Atmospheric Physics.

SOLAR RADIATION STATISTICS FOR AUSTRALIA

G. W. Patridge 1974 24 p refs

(ISBN-0-643-00082-8; Paper-23) Avail: NTIS HC \$4.25

Contour maps of seasonal average solar radiation parameters are computed from detailed cloud cover information. The parameters include direct and global fluxes on horizontal, inclined and 'sun-tracking' surfaces. Contour maps of cloud cover probabilities are included.

Author

MAN TURNS TO SUN AS ENERGY ALTERNATIVE.

W.A. Shumann.

Aviation Wk & Space Tech., Jan.14,1974, p.56-61.

Present demands for electricity and petroleum have generated renewed interest in using the sun's energy as a partial alternative. Companies with aerospace systems experience are now **virtually** alone in solar energy research.

A74-27323

Solar energy utilization by physical methods.
 M. Wolf (Pennsylvania, University, Philadelphia, Pa.). *Science*, vol. 184, Apr. 19, 1974, p. 382-386. 16 refs.

Wind power, ocean thermal gradient power, solar heat, and solar-to-electric power conversion are considered as means of solar energy utilization by physical methods. An **evaluation** is made of **total solar energy** delivery on the projected U.S. **energy economy**. It is estimated that the potential **solar** in photovoltaic arrays alone can exceed \$400 million by 1980 to meet the projected **capacity** buildup.

VZ

003409

Solar Energy and Wind Power. A Bibliography with Abstracts.
Edward J. Lehmann, and Axel C. Ringe.
National Technical Information Service, Springfield, Va. Jul
74. 162p NTIS-WIN-74-049
COM-74-11103/0WE PC\$20.00/MF\$20.00

The bibliography contains 154 selected abstracts of research reports retrieved using the NTIS on-line search system--NTISearch. The report is divided into two sections. The section on solar energy contains 100 abstracts dealing with solar heating for buildings, solar electric power generation, solar cells for terrestrial use, solar energy as a national resource, and solar stoves. The following 54 abstracts concerning wind power cover such topics as its future, conversion systems, energy storage, propeller design, and its uses. Many of these reports on wind power are recent NASA translations of European and Russian research conducted from 1934 to 1959.

PROSPECTS FOR SOLAR ENERGY.

M. Archer.

Futures, v.6, no.3, June 1974, p.261-267.

Article discusses national attitudes, heating and cooling buildings, other thermal applications, photovoltaic power, and photobiological energy conversion.

Research on Cadmium Stannate Selective Optical Films for Solar Energy Applications.

G. Haacke.

American Cyanamid Co., Stamford, Conn. Chemical Research Div. Apr 74. 43p NSF-RA/N-74-031, NSF-RANN/SE/GI-39539/PR/74-1
PB-232 883/9WE PC\$3.25/MF\$1.45

The objective of the program is the development of transparent, electrically conductive cadmium stannate (Cd_2SnO_2) coatings and their incorporation into solar energy conversion devices. Technology for the preparation of crystalline Cd_2SnO_4 films will be sought during the first phase of the program. Subsequently, the electrical and optical properties of these films will be optimized by adjustment of the deposition parameters and by controlled doping. The optical properties of Cd_2SnO_4 films will be determined and the use of these films evaluated as coatings for flat plate collector covers. Heat collection efficiencies will be measured on assembled flat plate collectors. Cadmium stannate films on transparent substrates will be used as back-wall electrodes in CdS solar cells and the photovoltaic properties of these devices will be investigated.

Solar Energy.

Vlastimir A. Stevovich.

Informatics Inc Rockville Md 1 Mar 74. 478p AFOSR-TR-74-0600

AD-778 846/6WE PC\$9.75/MF\$1.45

The report is a comprehensive review of present major developments and future planning in various fields of applied solar engineering. The study covers theoretical and experimental data on the background and state-of-the-art of applied solar research in general, with emphasis on foreign work, particularly in the Soviet Union. (Author)

Nature, v.249, June 21, 1974, p.726-729,

Solar energy

B. J. Brinkworth

Department of Mechanical Engineering, University College, Newport Road, Cardiff CF2 1TA, Wales, UK

Studies have been made of a very wide range of possible ways in which solar energy might be used for domestic and industrial purposes. Some are already economically viable and the prospects for others are improving through intensive programmes of research and development.

ELECTRONICS POWER, IEE VOL 20, NO. 9 (MAY 1974)
MAKING THE BEST USE OF SOLAR ENERGY. BY BRINKWORTH, B.J. (UNIVERSITY COLL., CARDIFF,
WALES) P 356-9

TITLE: Solar Energy Research Information Meeting
of NSF-RANN Grantees
CORPORATE AUTHOR: University of Pennsylvania,
National Center for Energy Management and
Power

ADDRESS: Philadelphia, PA

PUBLICATION DESCRIPTION: Papers presented at
meeting held March 15-16, 1973 at the
University of Pennsylvania, 188 p.

PUBLICATION DATE: 1973

SPONSOR: National Science Foundation, RANN Program

ABSTRACT: This report is a collection of papers
presented at this meeting which was convened
by NSF-RANN to provide a forum for solar
energy investigators to present their
research activities and discuss their points
of view concerning solar energy research
programs in general. Titles of the
presentations are as follows:

Solar-to-Thermal Energy Conversion
Application to Large Central Power Plants;
Photothermal Conversion of Solar Energy for
Large-Scale Electrical Power Production; The
Hanesota/Honeywell Solar Power Concept;
Solar Energy Thermal Converters Fabricated by
Chemical Vapor Deposition; Low-Cost Silicon
Solar Cells for Large Electrical Power
System-Growth of Silicon Layer on Steel
Substrate; An Improved Schottky Barrier
Photovoltaic Diode for Solar Energy
Conversion; Direct Solar Energy Conversion
for Large Scale Terrestrial Use; Modeling of
Solar Heating and Air Conditioning;
Conservation and Better Utilization of
Electric Power by Means of Thermal Energy
Storage and Solar Heating; Solar Energy
Residential System Modeling; Ocean Sited
Power Plants; An Inquiry into Biological
Energy Conversion; Biophotolysis of Water;
Technology for the Conversion of Solar Energy
to Fuel Gas (two papers); and Solar Energy
Panel Report. (PCN)

SYSTEMS ANALYSIS OF SOLAR ENERGY PROGRAMS. 309p.
UNCL
Dec. 1973

SYSTEMS ANALYSIS OF SOLAR ENERGY PROGRAMS. Appendix:
Research Tasks. 151p.
UNCL
Dec. 1973

MTR-6513
NSF/RA/N-73-3

Mitre Corp.
NSF-C831

Mitre Corp.
NSF-C831

MTR-6513-App.
NSF/RA/N-73-3-App.

73-WA/Sol-7 ■ A Tower Top Focus Solar Energy Collector. A. F. Hightbrant and L. L. Vant-Hull, University of Houston, Houston, Texas.

Solar energy can be usefully concentrated onto a central receiver by a large array of independently steered flat mirrors. In order that the reflected radiation all be intercepted, the central receiver must be elevated well above the mirror field. A receiver atop a 450-meter tower can effectively collect the radiation reflected from a 2.6 km square field of mirrors. By judiciously spacing mirrors over 45 percent of the area, such a system at 35 deg N latitude could collect 2700 Mw-Hr-Thermal/day in midwinter summer.

It is proposed that this heat be used to replace part of the fossil fuel burned in a conventional electrical plant during sunlit hours. Eventually, overnight storage of heat, e.g., in an eutectic salt, could reduce fuel usage to a standby basis.

An alternative approach is to use solar energy to generate hydrogen through decomposition of water. The influence of factors to produce the most economical energy from this capital intensive system, including thermodynamic efficiency, receiver temperature, and heliostat steering accuracy, are considered.

73-WA/Sol-8 ■ Survey of Solar-Powered Refrigeration. By R. K. Swarinen, Mem. ASME, W. Va., and A. J. Newton, University of Western Ontario, London, Canada.

A survey is carried out on the application of solar energy to refrigeration. The literature is reviewed in chronological order showing the progress since the first attempt in 1936.

Two systems are considered: the vapor-compression and the absorption systems. Various significant developments are reviewed and their potential critically assessed.

73-WA/Sol-9 ■ Effect of Boundary Surface Characteristics on Reflectance of Solar Radiation from Shallow Bodies of Water. by J. S. Toor, Assoc. Mem. ASME, Systems, Science and Software, La Jolla, Calif.

Analysis and results are presented for the total as well as the spectral distribution of the reflected (absorbed) solar radiation from shallow bodies of pure water. The directional dependence of the reflectance and transmittance of the air-water interface is included. Reflectance from the bottom surface is assumed direction independent.

The spectral nature of the water for its selective absorption and scattering is taken into account. The results are presented for four combinations of two types of interfaces, smooth and diffuse; three values of bottom reflectance; four values of depth, maximum being 15 cm; and two types of incident solar fluxes, collimated and diffuse.

Results have shown: as much as 58 percent increase in the total reflected flux and 150 percent increase in the absorbed spectral flux by properly choosing the type (diffuse or smooth) of the boundary surfaces.

73-WA/Sol-5 ■ Hybrid Solar Energy and Electric Heat Pump. by F. O. Calvert, Mem. ASME, and D. G. Harden, University of Oklahoma, Norman, Okla.

The potential for using solar energy for residential comfort heating is currently being considered as part of the long term solution to the world's dwindling fuel supplies.

This paper presents the results of a study to determine the feasibility of integrating the use of solar energy in an average residence by combining solar flat plate collectors with conventional residential heat pump systems. Savings in energy for the month of January were found to range from 6 to 62 percent depending upon the particular combination of solar collectors, storage capacity, and electric heat pump.

73-WA/Sol-3 ■ Compression Refrigeration from a Solar-Powered Organic Rankine-Cycle Engine. by S. L. Sargent, Assoc. Mem. ASME, University of Maryland, College Park, Md., and W. P. Teagan, Mem. ASME, Thermo Electron Corp., Waltham, Mass.

Solar-powered air conditioning is potentially one of the most advantageous solar applications, since its large-scale use would reduce peak electrical demand as well as total energy consumption.

Virtually all solar refrigeration systems have used an absorption cycle, but recent advances in the technology of Rankine-cycle engines, using organic working fluids such as Freon, put solar-powered compression refrigeration within the realm of technical feasibility.

73-WA/Sol-2 ■ Drainage Systems for Condensation. by C. Zener and A. Lavi, Carnegie-Mellon University, Schenley Park, Pittsburgh, Pa. (To be published in Trans. ASME—J. of Engrg. for Power.)

Efficient condensing surfaces are highly desirable in the design of solar sea power plants utilizing the ocean temperature difference. This paper examines a number of surface designs and presents a convenient method for optimizing the design. In particular, the various parameters of a Gregorig surface are optimized.

73-WA/Sol-4 ■ A Prototype Solar Kitchen. by C. J. Sweet, The Johns Hopkins University, Silver Spring, Md.

A prototype solar kitchen is described that can provide high grade thermal energy for a variety of household uses. The heat is available indoors, in the evening, during periods of intermittent cloudiness, and in high winds, without manual positioning to follow the sun.

The prototype unit is designed with the cooking and baking needs of a small family in mind, but the basic design is scalable to much larger heat delivery rates and adaptable to many other uses.

73-WA/Sol-1 ■ Transient Considerations of Flat-Plate Solar Collectors. by S. A. Klein, J. A. Duffie, and W. A. Beckman, Mem. ASME, University of Wisconsin, Madison, Wis. (To be published in Trans. ASME—J. of Engrg. for Power.)

The effects of thermal capacitance in the modeling of the performance of a flat-plate solar collector have often been neglected because of the computation involved. But because the solar collector is inherently exposed to continuously variable weather conditions, capacitance effects may be significant.

To investigate these effects, three different models of flat-plate collectors were investigated. The first, a quasi-steady-state model, simulates the performance of a collector of zero capacitance. The second model accounts for capacitance effects by assuming that a single value of thermal capacitance can be determined for the collector as a unit. The third model divides the collector into many isothermal segments, or nodes.

73-WA/Sol-3 ■ A Competitively Priced Alternative for Utilization of Solar Energy. by J. D. La Plante, Condescon Engineering Co., Las Cruces, N. M.; R. L. San Martin, and P. R. Smith, Assoc. Mem. ASME, New Mexico State University, Las Cruces, N. M.

Unique weather conditions of the southwestern United States make feasible the construction of a residence which employs solar energy utilization as an integral part of its design. Construction techniques utilized today in commercial buildings are adapted to make such a residence competitively priced with homes currently constructed by conventional methods.

The key problems in the design of competitively priced solar residences are the selection of materials and construction methods to ensure an economical, low heat load structure, and the choice of solar collection devices which are reliable, have low initial cost and require a minimum of maintenance.

TK
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1973

Intersociety Energy Conversion Engineering Conference, 8th Philadelphia, Pa., 1973.
Proceedings. New York, American Institute of Aeronautics and Astronautics [1973]
847 p. illus. 29 cm.
Held at: University of Pennsylvania, Philadelphia, Pa., August 13-16, 1973.
Sponsored by: American Institute of Aeronautics and Astronautics [and others]

A Combination of Solar Energy and the Total Energy Concept -- The Solar Community - R. B. POPE, W. P. SCHIMMEL, JR., D. O. LEE, W. H. McCULLOCH, B. E. BADER.....	304
Feasibility of Large-Scale Orbital Solar/Thermal Power Generation - J. T. PATA, G. R. WOODCOCK.....	312
A Computer Study of the Design and Operating Performance of a Photovoltaic Cell for Thermophotovoltaic Energy Conversion Applications - R. J. SCHWARTZ, N. F. GARDNER.....	320
Advances in Schottky Barrier Solar Cell Technology - W. A. ANDERSON, A. E. DELAHOY.....	326
Parametric Analysis of ATM Solar Array - B. K. SINGH, W. B. ADKISSON....	331
Development of a Lightweight Body-Mounted Solar Cell Array with a High Power to Weight Ratio - H. SOMBERG.....	338
Low Head Solar Water Pumping - C. J. SWET, H. G. FOX.....	341
Heliotropic Thermal Generators - C. J. SWET.....	348
An Analysis of Linear Focused Collectors for Solar Power - R. B. POPE, W. P. SCHIMMEL, JR.....	353
A Look at Solar Power for Seattle - H. OMAN, C. J. BISHOP.....	360
Molecular Greenhouses for Solar Farms: The Halogens - H. B. PALMER.....	366
Direct Conversion of Solar Energy, on Earth, Now - J. A. ECKERT, B. P. KELLY, R. W. WILLIS, E. BERMAN.....	372

TJ810.H29

The Coming Age of Solar Energy. Revised Edition. By Daniel Stephen Halacy. 1973. Harper & Row, 10 East 53rd Street, New York. N. Y. 10017. 231 pp., bound. \$7.95.

In this book, the author recounts the history of solar energy use through the centuries. He describes the many new concepts and hardware for using the sun's energy. One proposal suggests an orbiting solar collector which would beam energy as microwaves. Another envisions a huge solar-power complex in the Southwest desert country producing enough electricity for all the states. A third promising idea is the "sea thermal energy" plant, in effect a steam engine tapping the nearly limitless heat energy of the oceans. The book concludes with a plea for giving solar energy a chance to prove its promise by initiating more research projects investigating the possible uses of solar energy.

1973

QC
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De Jong, B

Net radiation received by a horizontal surface at the earth [by] B. de Jong.
[Groningen, the Netherlands] Delft University Press, 1973.

51 p. illus. 30 cm.

At end: 12 maps.

1. Solar radiation. I. Title.

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N74-17527# Argonne National Lab., Ill.
SOLAR ENERGY EVALUATION GROUP REPORT

Aug. 1973 48 p refs
(Contract W-31-109-eng-38)
(ANL-8045) Avail: NTIS HC \$4.00

A partial review of the status of various phases of solar-energy utilization and of some of the areas of potentially profitable research is reported. The review covers the biological and in vitro aspects of the photochemical conversion of solar energy; the photovoltaic, photochemical, and thermoelectric studies of the physical-conversion process; the use of solar energy for heating and cooling buildings; and the central-station power approach.

Author (NSA)

SUN IN THE SERVICE OF MANKIND.

Conf. in Paris, 2-6, July 1973, Organized by UNESCO.

Futures, v.5, no.5, Oct. 1973, p.511-514.
11 refs.

TITLE: Solar Energy May Achieve Wide Use by 1980's
CORPORATE AUTHOR: American Chemical Society
ADDRESS: 1155 16th St. NW., Washington, DC 20036
PUBLICATION DESCRIPTION: Chemical & Engineering News, 51(5), 12-13

PUBLICATION DATE: 1973, January 29

ABSTRACT: The Institute of Energy Conversion at the University of Delaware directed by Dr. Karl W. Root plans to demonstrate in a practical way the feasibility of solar energy conversion and utilization. The Institute will develop and construct practical solar houses with the total systems concept in mind. Such aspects as scientific, engineering, economic, legal, environmental, climatological, architectural, esthetic, sociological and psychological are considered. Private houses currently use 30 percent of the energy supplies, and if solar energy could supply just a fraction of this requirement, it would contribute an important role in preventing future energy shortages.
(PCM)

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1973

SOLAR ENGINE USING THE THERMAL EXPANSION OF METALS. Beam, R.; Jedlicka, J. Ames Research Center, Moffett Field, CA). Solar Energy; 15: No. 2, 133-142(Jul 1973).

A thermal engine with solid metal (stainless steel-304) as the single-phase working substance is described. The engine can consist of nothing more than a metal tube mounted in a bearing at either end so that it is free to rotate about its axis, with a fly-wheel mass at its midpoint. When the tube is heated on its upper surface, the region of its maximum compressive bending stress, it will rotate and produce steady power. Compared to engines using a gas or a liquid as the working substance, this engine has the disadvantage of low thermal efficiency but the advantage of simplicity. The solid metal phase engine may be useful for converting solar energy into small amounts of mechanical energy in underdeveloped regions of the world. (auth)

SCIENCE AND THE SUN.

Dr. Mary Archer.

New Scientist, Nov. 23, 1973, p.636-638.

Many of the possible applications of solar energy are little more than a gleam in the eyes of the scientific community; but the sun is too tempting a source to ignore.

HD9540.4 I5 1973

A73-35312* Some major terrestrial applications of solar energy. W. R. Cherry (NASA, Goddard Space Flight Center, Greenbelt, Md.). In: Institute of Electrical and Electronics Engineers, International Convention and Exposition, New York, N.Y., March 26-30, 1973, Technical Papers. (A73-35289 17-09) New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 6/3-1 to 6/3-8. 10 refs.

Three major areas of application are: (1) heating and cooling of buildings, (2) production of clean renewable fuels, and (3) generation of electrical power. No major scientific breakthroughs are needed to bring about the economic competitiveness of solar energy but merely the improvement of known materials, processes and engineering.

SOLAR ENERGY, ITS CONVERSION AND UTILIZATION

ERICH A. FARBER*

(Received 10 May 1971; in revised form 22 September 1972)

Abstract—This paper briefly presents a summary of solar energy research, comments on the need for continuing these studies, and describes the activities of the University of Florida Solar Energy Laboratory. These activities include converting solar energy to more practical forms of power, and devising ways to produce it in the fewest possible steps by the simplest means. The devices developed are used in the University of Florida Solar House with its Solar-Electric Car and solar-heated swimming pool.

*PROSPECTS FOR SOLAR ENERGY. Energy Policy; 1: No. 1, 83-84 (Jun 1973).

Three uses of solar energy were identified in the NSF-NASA panel report: heating/cooling of buildings, conversion of organic materials to fuels, and electric power generation. A breakdown of the 15-year R & D program covering all the Panel's recommendations is given. Possible ways of using solar energy are described briefly. (DLC)

A73-36331 # Solar power. E. R. G. Eckert (Minnesota, University, Minneapolis, Minn.). *American Institute of Aeronautics and Astronautics, Thermophysics Conference, 8th, Palm Springs, Calif., July 16-18, 1973, Paper 73-710*. 7 p. 10 refs. Members, \$1.50; nonmembers, \$2.00.

Discussion of the conversion of solar energy into thermal, chemical or electric energy. A crucial element in any scheme is shown to be the design of the solar collector. The conditions imposed by the specific application and the possibilities to obtain high collection efficiencies are investigated. Recent thin film technology developments are pointed out that have provided means for improvement of the absorber and the glass envelope of the collector. The storage of energy is also discussed. M.V.E.

N74-17790# Little (Arthur D.), Inc., Cambridge, Mass. **NEW SOURCES OF POWER: SOLAR ENERGY** Peter E. Glaser Sep. 1973 13 p Presented at the World Energy Supplies Conf., London, 18-20 Sep. 1973 Avail: NTS HC \$4.00

Two obstacles to harnessing solar energy, storage and collection, are discussed in terms of solar heating and cooling systems for buildings. The cost ranges for heating with solar energy are compared with the use of conventional fuels. Photovoltaic conversion of solar energy is discussed along with solar energy conversion in space, solar heat engine power plants, wind energy, and ocean thermal gradients for powering large heat engines.

Domestic Solar Energy Systems for Delaware.

Virendra Mohan Puri, and F. A. Costello. Delaware Univ., Newark. Inst. of Energy Conversion. May 73. 184p NSF-RA/N-73-026 PB-228 039/4WE PC\$5.50/MF\$1.45

The economics and performance of domestic solar energy system for Delaware is analyzed. Various performance factors, such as solar array orientation, cell temperature, atmospheric attenuation of solar radiation due to cloud cover, dust and air particle scattering, and water vapor and carbon-dioxide absorption, reflectance from different glass surfaces, radiation and convection loss to atmosphere, are accounted in the analysis. Three solar energy systems have been analyzed, solar electric only, solar electric only is expensive compared to current fossil-produced electricity, whereas the solar thermal/electric system is promising for the future. The solar thermal only system appears economical even with the current state of art. Economic sensitivity of the systems regarding the major cost parameters, solar cells, thermal collector, thermal storage and electric storage is discussed. Portions of this document are not fully legible. (Author)

A74-24941 * Conclusions and recommendations of the United States Solar Energy Panel. W. R. Cherry (NASA, Goddard Space Flight Center, Greenbelt, Md.) and F. H. Morse (Maryland University, College Park, Md.). In: Photovoltaic power and its applications in space and on earth; International Congress on the Sun in the Service of Man, Paris, France, July 2-6, 1973, Proceedings. (A74-24901 10-03) Brétigny-sur-Orge, Essonne, France, Centre National d'Etudes Spatiales, 1973, p. 587-597. 12 refs.

The United States Solar Energy Panel was charged with assessing the potential of solar energy as a national energy resource. Three areas evolved where solar energy could supply significant amounts of the U.S. future energy needs: (1) energy for heating and cooling of buildings, (2) the production of fuels, and (3) the generation of electrical power. It was concluded that with adequate R&D support over the next 30 years, solar energy could provide at least 35 percent of the heating and cooling of future buildings, greater than 30 percent of the methane and hydrogen needed in the U.S. for gaseous fuels, and greater than 20 percent of the electrical power needs of the U.S. All of this could be done with a minimal effect on the environment and a substantial savings of nonrenewable fuels.

HARNESSING SOLAR ENERGY: THE POTENTIAL.

Cherry, W. R. (Goddard Space Flight Center, Greenbelt, MD). *Astronaut, Aeronaut.*, 11: No. 8, 30-36 (Aug 1973).

Solar energy is inexhaustible and can be utilized with minimal impact on the environment. Three ways for the utilization of solar energy are heating and cooling of buildings, production of clean renewable fuels, and generation of electrical power. Improvement of known materials, processes, and engineering is needed. An investment of about two-and-a-quarter billion dollars over a 15-year period in solar conversion and collection technology will make available vast amounts of clean thermal energy and clean gaseous, liquid, and solid fuels to help relieve the dependence upon the unrenewable fossil fuels, particularly foreign sources of them, and thus rectify the balance of payments. By the year 2020 at least 20% (almost the total energy consumption of the USA in 1970) of the USA total energy needs could be met with solar-energy processes. (MCW)

(BNWL-1801) STUDY OF HANFORD CAPABILITY FOR SOLAR ENERGY RESEARCH AND DEVELOPMENT. Drumbeller, K. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Nov 1973. Contract AT(45-1)-1830. 55p. Dep. NTIS \$5.45.

The Hanford site provides unique capability for solar energy research and development. The basic attributes include large available land areas; consistent sunshine during much of the year (although not comparable to Arizona and the southwest U. S.); extreme temperatures for test purposes (-27 to 115 F); cooling water availability; ecology approximating ecology in some other solar areas; R&D facilities applicable to most solar technology; equipment immediately useful for solar energy programs; technology background in most areas of solar energy; experience with large energy systems, and background in systems analysis. From the solar energy production standpoint, the energy that falls on the 600 square miles at the Hanford site would produce 100,000 megawatts if 33 1/3% efficiency can be achieved. (MCW)

Power sources, Solar

Amer. Geophys. Union,
54th Ann. Meeting, Apr. 16-20,
1973, Wash., D.C.

U9 (Invited Paper; 30 min)
John A. Duffie
Solar Energy Lab.,
Univ. of Wis.,
1500 Johnson Dr.,
Madison, Wis. 53706

Solar Energy. Solar energy is a distributed resource large in magnitude, variable and intermittent in its availability for terrestrial energy needs. The easiest applications are in meeting thermal energy requirements of buildings; the solar energy incident on all but high-rise buildings generally exceeds thermal energy requirements of the buildings. If adopted for these uses alone, solar energy could make significant contributions to the U.S. energy economy. Conversion of solar to electrical or mechanical energy is approached by thermal processes (heat engines), but there are more difficulties to accomplish economically, but there is significant research in progress and proposed, and the potential impact is great. Research and development problems include: studies of materials with desirable radiation properties, development of economical solar energy "collectors", storage means for thermal or electrical energy, solar process studies, photovoltaic process research, and studies of availability of solar energy.

BRIGHTER OUTLOOK FOR SOLAR POWER.

G. Chedd.

New Scientist, Apr. 5, 1973, p. 36-37.

(WASH-1281-9) SOLAR ENERGY PROGRAM. Sub-panel Report IX Used in Preparing the AEC Chairman's Energy Report to the President. Eggers, A. J. Jr. (National Science Foundation, Washington, D. C. (USA)). 13 Nov 1973. 223p. Dep. NTIS \$14.25.

The goal of the Solar Energy Program is to develop and demonstrate economically competitive and environmentally acceptable solar energy systems at the earliest practical time. For each of the six subprograms, (1) heating and cooling of buildings, (2) solar-thermal conversion, (3) wind energy conversion, (4) ocean-thermal conversion, (5) bioconversion, and (6) photovoltaic conversion, the objective is to develop proof-of-concept experiments and demonstration projects that will allow industry and user agencies to begin aggressive commercialization of each of these technologies, thus assuring its widespread application. Funding for the five-year program is distributed among the six subprograms to permit the earliest proof-of-concept experimentation to be carried out. This will allow program management to concentrate at an early date on those technologies that show the most promise toward providing the Nation's energy requirements. The objectives that will have been accomplished by 1979 in each of the six subprograms are specifically delineated. Each of the six subprograms is analyzed under the following headings: (1) subprogram summary, (2) status of technology, (3) rationale for federal involvement and institutional arrangements for implementation, (4) criteria and priorities, (5) alternative R and D programs, and (6) implementation. Finally, in an appendix, research project titles and submitting organization of the proposals considered by the panel are listed. (LMT)

1973

Dissemination and Utilization of Solar Energy Research Results. Report to the Office of Systems Integration and Analysis Directorate of Applied Research, National Science Foundation.

Richard S. Greeley.

Mitre Corp., McLean, Va. Dec 73. 69p MTR-6544, NSD-RA/N-73-111D PB-231 144/WE PC\$3.75/MF\$1.45

Thirty recommendations have been made for establishing groups within or reporting to the NSF Solar Energy Program Office and initiating activities for the dissemination and utilization of solar energy research results. The primary recommendations include establishing an Advisory Commission and an information office reporting to the Program Director and constructing visitor centers on the sites of each Proof of Concept Experiment. Training courses and public education would be conducted at each center following successful operation of the POCE system. (Modified author abstract)

Research on Cadmium Stannate Selective Optical Films for Solar Energy Applications.

G. Haacke.

American Cyanamid Co., Stamford, Conn. Chemical Research Div. 1 Jul 73. 27p NSF-RA/N-74-016

PB-231 236/1WE PC\$3.25/MF\$1.45

The objective of the program is the development of transparent, electrically conductive cadmium stannate (Cd_2SnO_4) coatings and their incorporation into solar energy conversion devices. Technology for the preparation of crystalline

Cd_2SnO_4 films will be sought during the first phase of the program. Subsequently, the electrical and optical properties of these films will be optimized by adjustment of the deposition parameters and by controlled doping. The optical properties of Cd_2SnO_4 films will be determined and the use of these films evaluated as coatings for flat plate collector covers. Heat collection efficiencies will be measured on assembled flat plate collectors. Cadmium stannate films on transparent substrates will be used as back-wall electrodes in CdS solar cells and the photovoltaic properties of these devices will be investigated.

1973

TITLE: Systems Analysis of Solar Energy Programs
CORPORATE AUTHOR: Mitre Corp.
ADDRESS: 1820 Dolley Madison Blvd., McLean, VA 22101

PUBLICATION DESCRIPTION: Report No. NTR-6513, NSP/RA/N-73-111A, 215 p., 31 p. bibliography
PUBLICATION DATE: 1973, December

SPONSOR: National Science Foundation, RANW Program

ABSTRACT: this report----is one of a series of four NITRE reports (i.e. NTR-6513, NTR-6516, NTR-6537, and NTR-6544) that cover a NITRE Corporation Study of the NSF 5-year Solar Energy Research Program. This particular

document reports on the Systems Analysis task of the study. The approach utilized, in this part of the study, was as follows: Define a General Program Structure for Solar Energy Systems; Identify and describe the current state-of-the-art of solar energy research;

Assess the systems currently being studied under the NSF Solar Energy Research Program; Identify a set of problems that need to be solved during the course of the NSF Program;

Formulate a comprehensive set of required research tasks to solve these problems;

Identify a set of NSF-sponsored Proof-of-Concept Experiments that are needed to resolve critical problems of the Solar Energy Systems Program; and Describe a set of scenarios for the production and operational implementation of the types of systems included in the NSF 5-year Solar Energy Systems Program. Each of seven major applications of solar energy have been analyzed in this study, in terms of their costs and the benefits that are expected to accrue from their implementation. Of these seven applications, the Heating and Cooling of Buildings, Wind Energy Systems, and the Utilization of Organic Materials appear to be best capable of achieving commercial application within a few years. The other four applications, i.e. Process-Heat Systems, Solar-Thermal Systems, Photovoltaic Systems, and Ocean Thermal Gradient Systems, appear to need continued Federal Government support, with differing funding levels, and extending to varying lengths of time, beyond the initial NSF 5-year Program for Solar Energy Systems. (Auth)

HOW SOON THE SUN: A TIMETABLE FOR SOLAR ENERGY.
J.F. Henahan.

Saturday Review - World, Nov.20,1973, p.64,66.

TITLE: Systems Analysis of Solar Energy Programs
- Appendix: Research Tasks
CORPORATE AUTHOR: Mitre Corp.
ADDRESS: 1820 Dolley Madison Blvd., McLean, VA
 22101

PUBLICATION DESCRIPTION: Report No. NTR-6513
Appendix, NSP-RA/N-73-111, 151 p.
PUBLICATION DATE: 1973, December
SPONSOR: National Science Foundation, RANN Program
ABSTRACT: This Appendix contains a compendium of proposed Research Tasks for each of the seven Solar Energy Program Sub-Elements that are considered in NTR-6513, "Systems Analysis of Solar Energy Programs". These Research Tasks have been grouped, for each Sub-Element, in terms of Research Projects that cover studies under five different disciplines, i.e. Technical Studies, Economic Studies, Environmental Studies, Sociological Studies and Institutional Studies; as well as six subsystems or system functions, i.e. Collection Subsystems, Conversion Subsystems, Storage Subsystems, Transportation and/or Transmission and Distribution Subsystems, Utilization Subsystems, and Systems Integration. (Auth, from Introduction)

Solar Energy Research Program Alternatives. Proposed Research Tasks, Costs and Schedules for the National Science Foundation Five-Year Solar Energy Research Program.
Mitre Corp., McLean, Va. Dec 73. 149p MTR-6516. NSF-RA/N-73-111B
PB-231 141/3WE PC\$4.75/MF\$1.45

The MITRE Corporation is formulating a five-year solar energy research program as a recommendation to the National Science Foundation Applied Research Directorate Office of Systems Integration and Analysis. This document provides two alternative research plans, including task schedules and costs, for each of eight program elements: Heating and Cooling of Buildings, Process Heat, Thermal-Electric Energy Conversion, Photovoltaic Energy Conversion, Ocean Thermal Systems, Wind Energy Systems, Utilization of Organic Materials, and Common Applications. The two alternatives are: (a) a set of research tasks considered to be the minimum necessary to bring about the widespread utilization of solar energy and (b) an accelerated plan to achieve more rapid utilization, with a higher degree of confidence and reduced technical risk. (Author)

Solar Energy Proof of Concept Experiments.
Mitre Corp., McLean, Va. Dec 73. 106p MTR-6537. NSF-RA/N-73-111C
PB-231 143/9WE PC\$4.50/MF\$1.45

Critical experiments are described which are intended to prove the technical feasibility and socio-economic desirability of specific applications or techniques for the widespread use of solar energy. These experiments fall within the following areas: Heating and Cooling of Buildings, Process Heat, Thermal-Electric, Photovoltaic, Ocean Thermal, Wind Energy, Organic Materials and Common Applications. The specific concept which the experiment is intended to prove and a rationale for the experiment are given. Each experiment is described in terms of the system to be constructed, its pacing and high-risk items, the intended users, desired interfaces with other systems and users, and estimated costs for the experiment. Each experiment is described and costs estimated for two levels of funding: a moderate-risk 'minimum program' and a low-risk 'accelerated program'. (Modified author abstract)

TITLE: Dissemination and Utilization of Solar Energy Research Results
CORPORATE AUTHOR: Mitre Corp.
ADDRESS: 1820 Dolley Madison Blvd., McLean, VA
 22101
PUBLICATION DESCRIPTION: Report No. NTR-6548, NSP-RA/N-73-111D, 55 p.
PUBLICATION DATE: 1973, December
SPONSOR: National Science Foundation, RANN Program
ABSTRACT: Thirty recommendations have been made for establishing groups within or reporting to the NSP Solar Energy Program office and initiating activities for the dissemination and utilization of solar energy research results. The primary recommendations include establishing an Advisory Commission and an information office reporting to the Program Director and constructing visitor centers on the sites of each Proof of Concept experiment. Training courses and public education would be conducted at each center following successful operation of the POCE system. (Auth)

1973

HERE COMES THE SUN. Kenward, M. New Sci.; 59: No. 854, 71-72(12 Jul 1973).

There are many technological possibilities for solar energy. Most of them are well enough understood to convince all but the most skeptical that the Sun can contribute significantly to man's energy supplies. The question is, can these technologies be developed so that the energy is available at a reasonable price. The fuel for a solar power plant is free, but the capital cost can be very high to turn the Sun's radiation into electricity, hot water, distilled water, cold air, etc. The feasibility of harnessing solar radiation is not in doubt, but before we can plug into the Sun many technical questions still have to be answered. Problems discussed include size, collector design, weather dependency, use of satellite systems, and storage problems. (MCW)

A74-14465 Solar power for our nation. T. J. Kelly and J. Mockovciak, Jr. (Grumman Aerospace Corp., Bethpage, N.Y.). In: The second fifteen years in space; Proceedings of the Eleventh Goddard Memorial Symposium, Washington, D.C., March 8, 9, 1973. (A74-14463 03-34) Tarzana, Calif., American Astronautical Society, 1973, p. 39-54, 6 refs.

With increasing attention focusing on the energy problem, considerable interest has recently surfaced relative to the potential use of solar energy as a power source for our nation. This paper assesses the possibilities for near-term and longer-range applications of solar energy, including a large space-based Satellite Solar Power Station. Many applications are well beyond the research phase and could be accelerated to commercial readiness. Longer-range applications should be pursued with appropriate technology development programs to provide this nation with energy options in the future. If the nation wants to use solar energy as a major power source, it is technically possible to do so. Further, with appropriate incentives and government support, the public can have this clean and abundant energy source economically. (Author)

Technology Review, v.76, no.2, Dec.1973.

Solar Energy: Its Time Is Near 30
Walter F. Morrow, Jr.

Solar energy utilization requires no undiscovered fundamental science. With good fortune and good management, technology may deliver a \$25 billion solar energy industry by the year 2000

1973

RECENT DEVELOPMENTS IN SOLAR ENERGY RESEARCH AND APPLICATION IN JAPAN. Noguchi, T. (Government Industrial Research Inst., Nagoya, Japan). Solar Energy; 15: No. 2, 179-187(Jul 1973).

A ten-year review of solar energy research, development, and applications is given. Work on solar energy in Japan has been promoted and given more widespread support since the founding of the Japanese Association for Applied Solar Energy in 1961.

Recent developments in the summary include: air pollution, turbidity, and radiation measurement; agricultural applications; solar water heaters; solar power generation; high-temperature solar furnace work; architectural studies associated with solar radiation and environmental hygiene; and solar simulation. (70 references) (auth)

IS SOLAR ENERGY READY TO SOAR?

J.M. Nilsen.

Chem. Engineering, v.80, no.22, Oct.1,1973, p.24-26.

Between grandiose schemes for the future and esoteric research of the past, some applications of solar energy as a practical power source are beginning to emerge.

S-437

SOLAR ENERGY. D. Niskern.
Library of Congress-LC Science Tracer. Mar.1973.

Scope: Utilization of radiant energy from the sun for various purposes.

CN-140,186

1973

DIALOG ON ENERGY SUPPLY AND DEMAND. (Includes: **ENERGY-PRESENT STATUS AND PERSPECTIVES.** Marjorie P. Meinel, U. of Arizona. **SOLAR ENERGY - SOLUTION AND TECHNICAL CONSIDERATIONS.** Aden B. Meinel, U. of Arizona. **ENERGY - A REORIENTATION IN DEMAND.** Roger S. Carlsmith, ORNL-NSF Environmental Program). (Presented at LERC, Nov.15,1973). (Series title: Langley Colloquium Series). (1973). (Audiotapes - 2 sessions).

Arizona U.
Oak Ridge National Lab.
NASA

Langley Research Center

Power sources
Power sources, Solar
lectures - Power sources
Audiotapes - Energy crisis

L-12-11-73

AUSTRALIA SPEEDS UP SOLAR ENERGY RESEARCH.

Scholes, W. A. Energy Int.; 10: No. 10, 17-18 Oct 1973.

Short-term projects are concentrated on improving the efficiency and reducing the cost of existing types of solar water heaters and solar water-desalination plants. Longer-term projects include fundamental studies on thermal transfer problems, energy measurement, heat storage media, and solar-energy collectors.

An investigation of the distribution of solar energy over the continent is being carried out by CSIRO, Division of Atmospheric Physics. The development of devices for low-grade heat applications such as water heaters, air heaters, solar stills, and waste-heat solar stills is progressing. Transportation is a large consumer of primary energy in Australia, and extensive research and development is needed so that solar energy can provide both hydrocarbons and hydrogen as synthetic fuels to replace dwindling reserves of oil. Synthetic-fuels could be produced from plants that used solar energy to fix atmospheric carbon. Solar cells could be used for the electrolysis of water to produce hydrogen as a fuel and solar-powered cars could be developed. (ABC W)

THE ENERGY CRISIS: PART 2. TRAPPING THE SUN.

OS Staff.

Optical Spectra, Mar.1973, p.27-38.

NSF EXPANDS SOLAR ENERGY EFFORTS.

Technology Forecasts, Oct.1973, p.10,11.

N73-22748*# National Aeronautics and Space Administration.
Lewis Research Center, Cleveland, Ohio.

THE UTILIZATION OF SOLAR ENERGY TO HELP MEET OUR NATION'S ENERGY NEEDS ALSO A73-32193#
Ronald L. Thomas 1973 37 p refs Presented at Energy Crisis Symp., Albuquerque, 3-4 May 1973; sponsored by Natl. Profess. Soc. of N. Mex.
(NASA-TM-X-68230; E-7 39) Avail: NTIS HC \$4.00 CSCL 10A

The nation's energy needs, domestic energy resources, and possible future energy resources are briefly discussed in this paper. Three potential solutions, coal, nuclear and solar are compared as to benefits and problems. The paper primarily discusses the options available in using solar energy as a natural energy resource. These options are discussed under the generation of electricity, heating and cooling of buildings, and the production of clean fuel.

Author

N74-10754*# National Aeronautics and Space Administration.
Lewis Research Center, Cleveland, Ohio.

SOLAR ENERGY TO MEET THE NATION'S ENERGY NEEDS ALSO A74-30105#
Frank E. Rom and Ronald L. Thomas 1973 26 p refs Presented at Energy Facts for Concerned Citizens: A Natl. Forum, Boise, Idaho, 26-27 Apr. 1973
(NASA-TM-X-68290; E-7625) Avail: NTIS HC \$3.50 CSCL 10A

Solar energy, being a non-depleting clean source of energy, is shown to be capable of providing energy in all the forms in which it is used today. It can be used to generate electricity, for heating and cooling buildings, and for producing clean renewable gaseous, liquid and solid fuel. There is little question of the technical feasibility for utilizing solar energy. The chief problem is rapidly providing innovative solutions that are economically competitive with other systems.

Author

N74-12674* Auburn Univ., Ala. School of Engineering.
**TERRASTAR: TERRESTRIAL APPLICATION OF SOLAR
 TECHNOLOGY AND RESEARCH** Final Report
 Sep. 1973 344 p refs
 (Contract NGT-01-003-044)
 (NASA-CR-129012) Avail: NTIS HC \$19.25 CSCL 05A

The application of solar energy to the energy crisis of the 70's and beyond is discussed in the context of energy consumption in the U.S., energy resources in the U.S., and the state-of-the-art of solar energy applications. Solar energy application concepts, such as solar farms (a term used to describe vast fields of concentrators collecting solar energy for the generation-of steam to drive power turbines), an orbiting solar power station, and the conversion of solar energy into solar power for heating and cooling of individual buildings on the earth, are discussed. The report emphasizes the application of solar energy to the heating and cooling of buildings since this application seems to be more promising in the near term as far as research and development are concerned. The importance of initiating research and development on all solar application concepts is stressed as an important step in pursuing the use of solar energy. Immediate steps leading to the application of solar energy to heating and cooling of buildings are outlined to insure appreciable energy displacement through the use of solar energy by the year 2020. For individual titles, see N74-12675 through N74-12685.

N74-12681* Auburn Univ., Ala.
NATIONAL ENERGY POLICY

In its TERRASTAR: Terrest. Appl. of Solar Technol. and Res.
 Sep. 1973 12 p refs (For availability see N74-12674 03-34)
 CSCL 05A

The efforts of the U.S. government to cope with the national energy crisis are discussed. The provisions of several legislative actions to implement the actions for energy conservation are examined. Immediate conservation measures and the long range planning for energy resources are reported.

Author

N74-12682* Auburn Univ., Ala.
SOLAR ENERGY POTENTIAL

In its TERRASTAR: Terrest. Appl. of Solar Technol. and Res.
 Sep. 1973 9 p ref (For availability see N74-12674 03-34)
 CSCL 20M

The potential of solar energy as a national resource is discussed. Research and development programs for the development of eleven concepts are described to show the proposed funding for each year over a fifteen year period. The estimated energy contributions by period for each of the solar concepts are analyzed. The estimated impact of the solar concepts to the year 2020 are tabulated.

Author

N74-12683* Auburn Univ., Ala.
IMPACTS OF SOLAR ENERGY UTILIZATION c03
In its TERRASTAR: Terrest. Appl. of Solar Technol. and Res.
 Sep. 1973 25 p refs (For availability see N74-12674 03-34)
 CSCL 20M

Various methods of conducting surveys and analyses to determine the attitude of the public toward the energy crisis are discussed. Models to determine the impact of the energy crisis and proposed alternative sources of energy on the social structure are analyzed. The various interest groups which are concerned with energy and the nature of their interest are identified. The government structure for controlling resource production and allocation is defined.

Author

N74-12678* Auburn Univ., Ala.
COMPONENTS FOR SOLAR ENERGY c29
In its TERRASTAR: Terrest. Appl. of Solar Technol. and Res.
 Sep. 1973 14 p refs (For availability see N74-12674 03-34)
 CSCL 20M

A requirement for the direct technological utilization of solar energy is a device for capturing and absorbing the available sunlight. These devices are commonly termed collectors. Because of the highly variable nature of sunlight, a facility for storing the collected energy is often essential. A device for direct conversion of light into electricity, which depends for operation on incident sunlight, is the photovoltaic cell. These components for solar energy systems are considered.

Author

(UCRL-51315) OUR SOLAR ENERGY OPTIONS:
 PHYSICAL AND BIOLOGICAL. Tamplin, A. R. (California Univ., Livermore. Lawrence Livermore Lab.). 2 Jan 1973.
 Contract W-7405-eng-48. 23p. Dep. NTIS \$4.00.

Various schemes that have been proposed for the utilization of solar energy are discussed. The first section discusses physical systems and the second section treats biological systems. The major focus of the report is to present a means of comparison; consequently, the technical description is somewhat brief. More detailed technical discussions can be found in the 56 cited references. (auth)

see: **SOLAR ENERGY. A.R. Tamplin.**

Environment, v.15, no.5, June 1973, p.16-20,
32-34.

This article is essentially the above report.

1973

The potential impacts of solar energy. M. Wolf (Univ Pennsylvania, Philadelphia, USA). EASCON '73. Revised, Washington, D.C., USA, 17-19 Sept. 1973 (New York, USA: IEEE 1973), p.95-106
The performance and present status, problems to be solved and expected achievements for the various approaches are reviewed. Heating and cooling of buildings, obtaining storable fuels through photosynthesis, generation of electric power via thermal of photovoltaic conversion in distributed or central station systems, including satellites in geostationary orbit, and indirect utilization via wind power or ocean thermal gradients are discussed. The expected times of commercial readiness, introduction rates, energy delivery, and other economic impacts are discussed. (15 refs.)

CATCHING SUNBEAMS. David Brand.
Wall Street Jour., 181:14 Apr.16,1973.

Old dream of putting sun's power to work gets renewed attention: earthly energy shortages spur research into ways to collect and use solar rays.

POWER FROM THE SUN: THE SEARCH PICKS UP.
U.S. News & World Rept., Apr.16,1973, p.90-91.

As signs of a fuel crisis grow more ominous, scientists are spurring efforts to tap the awesome power of the sun to help meet earth's energy needs.

SOLAR ENERGY FOR MAN. Brinkworth, B. J. Halsted Press Book. New York: John Wiley and Sons, Inc. (1972). 261p. \$8.95.

Ways of coping with the power needs in view of growing populations and lagging development are investigated. Most of the world's energy has come from the energy stored in fossil fuels, but the exhaustion of these stocks is foreseeable and other sources must be considered. Nuclear plants can be expected to meet the large-scale demand in the long term. Solar energy is plentiful in those countries most urgently needing power and is suitable for small, local demands in isolated places. Solar energy for Man contains 10 chapters: Energy and the Human Condition; The Sun and the Earth; A Review of First Principles; Collection of Solar Energy; Heating by Solar Energy; Conversion of Solar Energy into Work; Conversion of Solar Energy into Electricity; Photoelectricity; Photochemistry and Photobiology; and the Introduction of Solar Power. (MCW)

TITLE: Solar Energy: An Endless Supply
AUTHOR: Wolf, M.
CORPORATE AUTHOR: Pennsylvania, University of, National Center for Energy Management and Power

ADDRESS: Philadelphia, PA
PUBLICATION DESCRIPTION: Consulting Engineer, 40(3), 171-179

PUBLICATION DATE: 1973, March
ABSTRACT: Energy consumption in the U.S. is reviewed, including limitations to fossil and nuclear fuel consumption. The economics of the energy situation are considered. The four basic methods of utilizing solar energy are: indirect utilization through hydropower, wind, or ocean thermal gradients; utilization of photosynthesis to convert to chemical energy; direct use of solar energy for heating; and conversion into electricity. Each method is reviewed, including the time scale for development of the methods. Solar energy should become a significant part of the future mix of energy sources in the medium and long range. (MPC)

N73-33762# Cooperation Mediterranee pour l'Energie Solaire, Marseille (France).
MEDITERRANEAN COOPERATION FOR SOLAR ENERGY. BULLETIN NO. 22 [COOPERATION MEDITERRANEE POUR L'ENERGIE SOLAIRE. BULLETIN NO. 22]
Mar. 1972 91 p refs In FRENCH
(Bull-22) Avail: NTIS HC \$6.75

Conference data on the use of solar energy in the Mediterranean are presented. Various techniques and equipment are also described. For individual titles, see N73-33763 through N73-33773.

1972

TK Intersociety Energy Conversion Engineering
2896 Conference, 7th, San Diego, Calif., 1972.
I 55 Proceedings. Washington, D. C., American
1972 Chemical Society, 1972.
: 1533 p. illus. 28 cm.

A Solar-Electric Residential Power System, C. E. Backus 704
A Systems Engineering Overview of the Satellite Solar Power Station
J. Mockovciak, Jr. 712
A Universal Solar Kitchen, C. J. Swat 724
The Energy Plantation, G. C. Szego, J. A. Fox, D. R. Eaton. 1131

CONCENTRATED SOLAR ENERGY EFFORT URGED.
Aviation Wk. and Space Tech., v.96, no.16, Apr.17,1972,
p.16.

NASA-Nat. Science Foundation panel expects to
recommend a two-year program in the range of 15-35
million to start a concerted government effort
to trap the sun's radiation for energy.
see also (AW&ST, Mar.27, p.21.)

FUTURE LARGE SCALE TERRESTRIAL USE OF SOLAR ENERGY.
K.W. Boer.
25th power sources symposium, May23-25,1972, p.145-
148.

SOLAR ENERGY RESEARCH SPONSORED BY THE NATIONAL
SCIENCE FOUNDATION. J.C. Denton and L.O. Herwig.
p.137-138.

1972

(PB-221659-6) ASSESSMENT OF SOLAR ENERGY
AS A NATIONAL ENERGY RESOURCE. Donovan, P.; Woodward,
W.; Cherry, W.R.; Morse, F.H.; Herwig, L.O. (Maryland Univ.,
College Park (USA). Dept. of Mechanical Engineering). Dec 1972.
85p. NTIS \$2.75.
Solar energy is received in sufficient quantity to make a major
contribution to the future U. S. heat and power requirements. There
are numerous conversion methods by which solar energy can be
used for heat and power, e.g., thermal, photosynthesis, bioconver-
sion, photovoltaics, winds, and ocean temperature differences.
There are no technical barriers to wide application of solar energy
to meet U. S. needs. The technology of terrestrial solar energy
conversion has been developed to its present limited extent through
very modest government support and some private funding. For
most applications, the cost of converting solar energy to useful
forms of energy is now higher than conventional sources, but due
to increasing prices of conventional fuels and increasing con-
straints on their use, it will become competitive in the near future.
Recommendations are discussed. (GRA)

TITLE: Conclusions and Recommendations of the
Solar Energy Panel
AUTHOR: Cherry, W.R.; Morse, F.H.
CORPORATE AUTHOR: National Aeronautics and Space
Administration, Goddard Space Flight Center;
Maryland, University of
ADDRESS: NASA, Greenbelt, MD; University of
Maryland, College Park, MD
PUBLICATION DESCRIPTION: Paper No. 72-WA/Sol-5,
contributed by the Solar Energy Applications
Group of The American Society of Mechanical
Engineers for presentation at the Winter
Annual Meeting, New York, NY, November 26-30,
1972, 12 p.

PUBLICATION DATE: 1972
ABSTRACT: In response to the President's June 8,
1971 energy message to the U.S. Congress, the
Solar Energy Panel was established within the
Committee for Energy R & D Goals, under the
Federal Council of Science & Technology in
the Office of the White House. The purpose
of the panels was to review the potential use
of various energy sources and to recommend R
& D effort which should be undertaken to
assure our Nation an abundant supply of clean
energy in the future. Three areas evolved
where solar energy could supply significant
amounts of the Nation's future energy needs.
It was concluded that with adequate R & D
support over the next 30 years, solar energy
could provide at least 35 percent of the
heating and cooling of future buildings,
greater than 30 percent of the methane and
hydrogen needed in the U.S. for gaseous
fuels, and eventually greater than 20 percent
of the electrical power needs of the U.S.
All of this could be done with a minimal
effect on the environment and a substantial
savings of nonrenewal fuels. (Auth)
AVAILABILITY: The American Society of Mechanical
Engineers, United Engineering Center, 345
East 47th St., New York, NY 10017 (\$3.00 per
copy, \$1.00 to ASME members)

ENERGY REQUIREMENTS OF THE FUTURE.

Gaucher, L. P. Solar Energy; 14: No. 1, 5-10 (Dec 1972).
In 1965 at a Solar Energy Society meeting in Phoenix, Arizona, it was predicted that a large amount of solar energy would be required in another 30 to 40 yr to supplement nuclear energy and the world's dwindling supply of fossil fuels. Since then, many things have occurred to reinforce this prediction and we are now six years closer to the time when solar energy will be needed. However, the research and development work that must be done before solar energy can take its place among other large sources of energy will be extensive and expensive. This work will have to be supported by the governments of the world, just as atomic energy was. Steps should be taken now to promote awareness of the ultimate need for solar energy and to promote the allocation of funds for the research and development work required. (auth)

TITLE: The Solar Alternative to Atomic Power
AUTHOR: Malachuk, D.S., Jr.
COMPOSITE AUTHOR: General Electric Co.
PUBLICATION DESCRIPTION: Science Digest, 71(1), 35-52

PUBLICATION DATE: 1972, March
ABSTRACT: Solar energy, which is free of pollution, can be used to heat homes, heat water, desalt water, and generate electricity. "Sea-thermal-energy plants" use the sea as a flat-plate collector for generating electricity and producing fresh water. Other methods of collecting solar energy are described, including satellite power stations, the heliostats' solar farms, and the solar battery. Solar power is too expensive to be widely used now, but advances in technology and mass production could change the situation. (NPG)

TITLE: Large-Scale Utilization of Solar Energy
AUTHOR: Haas, G.P.
COMPOSITE AUTHOR: Houston, University of; Mitre Corp.

ADDRESS: University of Houston, Cullen Blvd., Houston, TX 77008; Mitre Corp., Westgate Research Park, McLean, VA 22101
PUBLICATION DESCRIPTION: N72-168, Paper presented at the Symposium on Energy, Resources and the Environment, Kyoto, Japan, July 11, 1972; 35 p.

PUBLICATION DATE: 1972, September
ABSTRACT: The utilization of solar energy on a large scale offers a long-range solution to the problems of providing an adequate source of energy with minimal ecological disruptions. Because of the nature of solar energy, the use of this energy to produce a fuel appears most attractive. The development of this source and its economic feasibility will depend upon the commitment of resources by the technologically advanced nations. One possible large-scale thermal system will be discussed to illustrate some of the problems. (Auth)

N73-11060# Army Foreign Science and Technology Center, Charlottesville, Va.
CONTEMPORARY STATUS OF STUDIES ON DIRECT CONVERSION OF SOLAR ENERGY TO ELECTRICAL ENERGY
N. S. Lidorenko 28 Jul. 1972 11 p refs Transl. into ENGLISH from Geliotekhnika (Teshkent), no. 6, 1969 p 3-9 (AD-747293; FSTC-MT-23-1429-71) Avail: NTIS CSCL 10/2 Photoelectric, thermoelectric and thermomission methods of direct conversion of solar energy into electric energy are studied. The article presents a review of modern methods of investigation. Author (GRA)

N74-12482# Maryland Univ., College Park. Dept. of Mechanical Engineering.
AN ASSESSMENT OF SOLAR ENERGY AS A NATIONAL ENERGY RESOURCE
Dec. 1972 88 p refs Sponsored by NASA (Grant NSF GI-32488) (NASA-CR-136191; PB-221659; NSF/RA/N-73-001) Avail: NTIS HC \$6.50 CSCL 038

The findings of a panel on the development and application of solar energy to reduce the need for fossil fuels are presented. The applications which are considered most promising from technical, economic, and energy quantity standpoints are: (1) heating and cooling of residential and commercial buildings, (2) chemical and biological conversion of organic materials to liquid, solid, and gaseous fuels, and (3) generation of electricity. Tables are presented to show the solar utilization techniques, major technical problems, and the impact of solar energy applications on the reference energy system. Author

N72-31082# National Academy of Sciences-National Research Council, Washington, D.C. Board on Science and Technology for International Development.

SOLAR ENERGY IN DEVELOPING COUNTRIES: PERSPECTIVES AND PROSPECTS
Mar. 1972 60 p refs (Contract AID/csd-2584) (PB-208550; TA/OST-NAS-72-34) Avail: NTIS HC \$4.50 CSCL 10A

This is a report of an ad hoc advisory panel, made up of specialists from the United States and abroad, to: (1) assess the state of the art in utilizing solar energy for developing countries and review current practical applications; (2) identify promising areas for research and development; and (3) examine the desirability of establishing an international solar energy institute in North Africa, to carry out solar energy research and development. GRA

THE ENERGY RESOURCES AND ELECTRIC POWER SITUATION IN THE UNITED STATES. M. Altman, et al. Energy Conversion, v.12, p.53-64, 1972.

Contains sections on:

- The case for solar energy.
- Is residential solar energy conversion feasible?
- The impact of the solar house on the national energy budget.
- Other energy benefits of the solar house.
- Economy and timeliness.
- The use of solar energy in the synthesis of fuels.
- Solar superheaters.

N73-13866* Florida Univ. Gainesville. Solar Energy and Energy Conversion Lab. **NASA SP-313**
SOLAR ENERGY, ITS CONVERSION AND UTILIZATION c03

Erich A. Farber. In NASA. Marshall Space Flight Center. Space for Mankind's Benefit 1972 p.369-388 (For availability see N73-13829 04-30)
 CSCL 10C

The work being carried out at the University of Florida Solar Energy and Energy Conversion Laboratory in converting solar energy, our only income, into other needed and useful forms of energy, is described. A treatment such as this demonstrates, in proper perspective, how solar energy can benefit mankind with its many problems of shortages and pollution. Descriptions were given of the conversion processes, equipment, and performance. The testing of materials, solar water heating, space heating, cooking and baking, solar distillation, refrigeration and air-conditioning, work with the solar furnace, conversion to mechanical power, hot air engines, solar-heated sewage digestion, conversion to electricity, and other devices will be discussed. Author

A73-18029 In-depth exploration of the solar system and its utilization for the benefit of Earth. K. A. Ehrcke (North American Rockwell Corp., Space Div., Downey, Calif.). (New York Academy of Sciences, Conference on Planetology and Space Mission Planning, 3rd, New York, N.Y., Oct. 28-30, 1970.) New York Academy of Sciences, Annals, vol. 187, Jan. 25, 1972, p. 427-456. 5 refs.

SOLAR ENERGY: THE LARGEST RESOURCE. Hammond, Allen L. Science; 177: No. 4054, 1088-90(22 Sep 1972). The potential of solar energy for solving the world's energy problem is briefly discussed. Systems for utilizing solar energy for heating and air conditioning of homes and electricity production are presented. (T.F.D.)

PROGRESS IN UTILIZATION OF SOLAR ENERGY. Gupta, C. P.; Mehrota, R. K. (Univ. of Roorkee, India). J. Inst. Eng. (India); 53: No. 1, 13-27(1972). The specific progress of solar energy utilization and its advantages are discussed. (27 references.) (Indian Sci. Abstr.)

POTENTIAL OF SOLAR ENERGY APPLICATIONS.

Glaser, P. E. (Arthur D. Little, Inc., Cambridge, MA). AICHE Symp. Ser.; 68: No. 125, 55-65(1972).

The total influx from solar, geothermal, and tidal energy into the Earth's surface environment is estimated to be $173,000 \times 10^{12}$ watts. Solar radiation accounts for 99.98% of it. The Sun's contribution to the energy budget of the Earth is 5,000 times the energy input from all other sources combined. The applications of heating from solar energy include domestic hot water heating, residential cooling and heating. Photochemical reactions are discussed in view of harnessing the energy involved for domestic applications. Direct energy conversion based on photovoltaic conversion of solar energy into dc, employing solar cells, is discussed. Focusing collectors based on mirror reflectors or Fresnel lens concentrators can be used to obtain high temperatures. A system based on selective radiation-absorbing surfaces maintained inside an evacuated cylinder, with the heat transferred to a circulating gas or fluid has been proposed. Sun-heated oceans present a possible energy source. The harnessing of energy in space was discussed. (JCW)

N73-14812# Committee on Science and Astronautics (U. S. House).
SOLAR ENERGY RESEARCH. A MULTIDISCIPLINARY APPROACH
 Philip B. Yeager Washington GPO 1973 120 p refs Presented by the Comm. on Sci. and Astronaut. at the 92d Congr. 2d Sess., 27 Dec. 1972
 Avail: Comm. on Sci. and Astronaut.

Data reported to the Committee on Science and Astronautics on the current status and future potential of solar energy research are outlined. The information covers extent of need, who is doing the research and development, level of effort being extended, what the obstacles are - technological, economical, political and social, and the degree of reliance that can and should be placed in solar energy.
 Author

TITLE: Solar Energy Conversion - An Emerging Option for The Ecological Future

AUTHOR: Weingart, J.
COMPOSITE AUTHOR: California Institute of Technology, Environmental Quality Laboratory
ADDRESS: Pasadena, CA 91109

PUBLICATION DESCRIPTION: Environmental Quality Magazine, December 1972, 5 P., originally published under the title "Everything You Always Wanted to Know About Solar Energy But Were Never Charged Up Enough to Ask"

PUBLICATION DATE: 1972

ABSTRACT: This article briefly reviews the amount of power available from solar energy, and the advantages and disadvantages of utilizing solar energy. The use of solar energy for water heating, space heating and cooling, and electric power generation is described. Other ways to utilize solar energy include biological conversion to produce methane, hydrogen, and other gaseous fuels and the use of satellites to convert solar energy to microwaves to heat power to earth. The author feels that to ignore solar energy as one option for a U.S. energy system would be "a major act of ecological irresponsibility".

HARNESSING THE SUN. Robert F. Hudcock

Astronautics & Aerorautics July 1972 p. 6-9

NEW LOOK AT SOLAR ENERGY.

Technology Forecasts, v.4, no.9, Sept.1972, p.13-15.

PHYSICS LOOKS AT SOLAR ENERGY.

A.B. Meinel and M.P. Meinel.

Physics Today, Feb.1972, p.44-50.

NASA PLANS EXPANDED PROGRAM TO EXPLOIT SPACE SOLAR POWER. K. Johnsen.
 Aviation Wk & Space Tech., v.96, no.13, Mar.27,1972, p21.

S-403

ON THE WAY: PLENTIFUL ENERGY FROM THE SUN.
 C.P. Gilmore.

Popular Science, Dec.1972, p.86-114.

THE SOLAR ERA - PART 1 THE PRACTICAL PROMISE.
 L.P. Caucher.

Mech. Eng., Aug.1972, p.9-12.

THE SOLAR ERA. PART 3--SOLAR RADIATION: SOME IMPLICATIONS AND ADAPTATIONS.

Mechanical Engineering, Oct.1972, p.24-29.

Are obsessions concerning transmissible energy, plug-in convenience, "economics of scale," and conventionality retarding direct and effective use of solar energy? Here are some related thoughts and observations.

THE SOLAR ERA: PART 5 - THE POLLUTION OF OUR SOLAR ENERGY. R.K. Swartman, et al.

Mech. Eng., v.94, no.12, Dec.1972, p.23-26.

Extreme consequences of air pollution could be: another ice age, melting polar ice caps, massive carcinogenic UV radiation. Government, industry and the public must make the effort and pay the price to reverse the rising pollution down to a rational minimum.

1971

1971
CN-140,005
ENERGY RESEARCH NEEDS. Sam H. Schurr. ((Final rept.))
Jan.15-Aug.15,1971. (Prepared for NSF). Oct.1971.

Resources For The Future, Inc.
Washington, D.C.

(National Science Foundation NSF-RANN-71-2)
National Technical Information PB 207 516
Services
(NSF-C-644)

Power sources
Energy consumption
Fuels
Power sources, Nuclear
Power sources, Solar
Engines, Automobile
Pollution
Public Service
L-9-28-73

N74-16514# Little (Arthur D.), Inc., Cambridge, Mass.

A NEW VIEW OF SOLAR ENERGY

Peter E. Glaser and James E. Murphy 1971 12 p refs Presented
at Intersoc. Energy Conversion Eng. Conf., Boston. 3-6 Aug.
1971

Avail: NTIS HC \$3.00

The use of solar energy as a comprehensive national energy
policy is discussed in terms of its social, economic, and
environmental effects. Also considered are the nature of solar
energy, practical considerations, and research needs. K.M.M.

TITLE: Hydrogen for Energy Transport and Storage
in Solar Energy Systems

AUTHOR: Hoffman, K.C.; Winsche, W.F.

CORPORATE AUTHOR: Brookhaven National Laboratory,
Upton, N.Y.

PUBLICATION DESCRIPTION: BNL 16259,

CONF-711035-1, paper presented at Third

Conference on Large Scale Solar Energy

Conversion for Terrestrial Use, 6 p.

PUBLICATION DATE: 1971

ABSTRACT: Hydrogen provides a promising
alternative method of sorting and delivering
solar derived energy to urban load centers,
particularly when this fuel, rather than
electricity, is delivered to the consumer.
Additional study is required of cavern
storage techniques and of safety matters
associated with the use of hydrogen. (Auth)

SOLAR RADIATIONS AND THE EARTH.
(Proceedings of symposium held Univ.
of Delhi, 1971).

J.N. Tandon, Ed.

Dist. D. Reidel. 1972.

73V45543 1971 ISS OC TJ810.M44 621.47 LC-73-299022

A/MEINEL, ACEN B.

POWER FOR THE PEOPLE BY ADEN BAKER MEINEL AND MARJORIE PETTIT
MEINEL.

TUCSON, ARIZ., XIV, 270, 8 P. ILLUS. 29 CM.

LC SOLAR ENERGY.

ADDED MEINEL, MARJORIE PETTIT, JOINT AUTHOR.

MAIN-AUTH TRACE-TITL*AUTH# CAILG BY-LC

517

N74-16512# Hydrometeorological Publishing House, Leningrad (USSR).

SOLAR RADIATION AND RADIATION BALANCE DATA (THE WORLD NETWORK): ANNUAL DATA, 1964 - 1968 T. G. Berland, ed. 1970 600 p In ENGLISH and RUSSIAN Avail: NTIS HC \$32.00

A reference guide of global radiation and radiation balance data is presented for Africa, Asia, South America, North America, Southwest Pacific, and Europe. Tables presented include: monthly and annual values of global radiation, monthly annual values of radiation balance, hourly values of global radiation, and hourly values of radiation balance. F.O.S.

72V29090 1969 ISS OC TJ81C.H255 1969 621.47 LC-65-18892

A/HALACY, DANIEL STEPHEN, A/1915-

EXPERIMENTS WITH SOLAR ENERGY BY D. S. HALACY, JR.

1ST ED. W. W. NORTON NEW YORK, 147 P. ILLUS. 22 CM.

4.14 BIBLIOGRAPHY P. 141 INSTRUCTIONS FOR PERFORMING EXPERIMENTS

WHICH DEMONSTRATE MANY POSSIBLE USES FOR PRESENTLY WASTED SOLAR ENERGY.

LC SOLAR ENERGY -- JUVENILE LITERATURE. SOLAR ENERGY.

MAIN-AUTH TRACE-TITL* CATLG BY-LC

/ /

72V1600b 1908 ISS OC TJ81C.H6 621.47 LC-68-10336

A/HOKE, JOHN, A/1925-

SOLAR ENERGY. FCREWCED BY HUBERT HUMPHREY. ILLUSTRATED WITH PHOTCS.

AND DRAWINGS.

F. WATTS NEW YORK, 83 P. ILLUS. 23 CM.

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LC SOLAR ENERGY.

MAIN-AUTH TRACE-TITL* CATLG BY-LC

/ /

REVIEW ARTICLE

A Philosophy for Solar Energy Development*

G. O. G. LÖFt, D. J. CLOSE† and J. A. DUFFIE†

(Received 25 April 1968)

INTRODUCTION

ON LOOKING back on the ten years which have elapsed since the Tucson and Phoenix Conferences, one is struck by the successful application of a few solar processes, and the lack of successful application of many others. Salt manufacture by solar evaporation of sea water has been widely used for centuries. Solar water heaters of various types are now accepted in many countries, and solar distillation using the basin type still is approaching the status of a practical and economically satisfactory device. Silicon cells are used in space and for special terrestrial applications. These systems have all been the subject of extensive engineering development and economic evaluation.

This paper is concerned with the reasons for the evident success of these solar processes, and the lack of success of others (solar air conditioners, refrigerators, mechanical and electrical power systems), especially with regard to underdeveloped areas where they were expected to be of greatest use. From these reasons, conclusions are drawn as to what sort of development program is likely to be most successful in stimulating future applications of solar processes. Finally, the argument for adopting a systematic and comprehensive program is presented and explained by use of specific examples.

TK2896.155 1968 v.1

Intersociety Energy Conversion Engineering Conference. Boulder, Colorado, 1968.
Record. Held at the University of Colorado, Boulder, Colorado, Aug. 13-17, 1968. New York, Institute of Electrical and Electronics Engineers, 1968.

"Worldwide Progress in Solar Energy." F. E. Edlin,
Arizona State University 689012 92
 "The Future of Power from the Sun," P. E. Glaser,
A. D. Little 689014 98
 "Energy Gap — DEC Teaching." R. L. Bailey, *University of Florida* 689015 105

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Daniels, Farrington, 1889-

Direct use of the sun's energy. New Haven, Yale University Press, 1964.

xvii, 374 p. illus., maps. 21 cm. (Trends in science, v. 5)
 Includes bibliographies.

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Rau, Hans, 1881-

Solar energy. Translated by Maxim Schur. Edited and rev. by D. J. Duffin. New York, Macmillan, 1964.

171 p. illus., ports. 21 cm.
 Bibliographical footnotes.

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Zarem, A M ed.

Introduction to the utilization of solar energy (by, Far-
rington Daniels (and others), Edited by A. M. Zarem (and),
Duane D. Erway. New York, McGraw-Hill (1963,

398 p. illus. 24 cm. (University of California engineering and
sciences extension series)

Based on a course in solar energy utilization given at the Univer-
sity of California, Los Angeles.
Includes bibliography.

SYMPOSIUM ON RESEARCH FRONTIERS IN SOLAR
ENERGY UTILIZATION. (Presented before the
National Academy, April 24, 1961).
Proceedings of the National Academy of
Sciences of the United States of America,
v.47, no.8, Aug.1961, p.1245-1306.

Contents: Survey of research fields and
needs. Solar energy in the exploration of
space. Research on the use of solar energy
made in the Soviet Union. Solar collectors,
selective surfaces, and heat engines.
Fundamental problems in solar distillation.
The storage of heat and electricity. Photo-
chemical utilization of light energy. Photo-
electricity.

B/8

1962

Biography - Goddard

Power sources, Solar

Solar collectors

Vaporizers

Mirrors

11.11, 12.3

R.H. GODDARD AND SOLAR POWER 1924-1934.
E.R. Hagemann, Aerospace Corp. Solar Energy
v. VI, no.2, p.47-54. April-June 1962.

From 1924 through 1934, Professor Robert H.
Goddard, primarily known for his rocket
work, engaged in considerable research in
solar power and conversion. He was granted
five patents and constructed several labora-
tory test models of his various apparatus.
Goddard's principal contributions were his
correction of errors in the work of others
and his conversion studies. He envisioned
his work being applied both to space travel
and to supply abundant and cheap terrestrial
power.

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In8

International Seminar on Solar and Aeolian Energy

Solar and Aeolian energy. (Proceedings of

Seminar, held in Smirni, Greece, Sept.4-15,1961).

Edited by A.G. Spanides. (Publication of NATO

Institute of Advanced Studies in Solar and Aeolian

Energy, Athens, Greece). New York, Plenum Press, 1964

ix, 491p. (Eng. & Fr. text)

1961

1961

N-78623, v.1
AN ANALYSIS OF SOLAR ENERGY UTILIZATION.
VOLUME I, PART I - CONCLUSIONS AND RECOMMENDATIONS. PART II - SUBJECT INDEX.
J.H. Fisher. Feb.1959. 38p.

Wright Air Development Center TR 59-17, v.1
Electro-Optical Systems, Inc.
Contract AF-33(616)-5564
(ASTIA AD 214611)
Author

The program of study and analysis which has culminated in the preparation of this report was directed toward the evaluation of three conversion mechanisms: solar energy to heat energy, solar energy to mechanical energy, and solar energy to electrical energy. Program includes a technical analysis of flat-plate solar collectors, concentrating solar collectors, photovoltaic converters, thermopiles and thermionic emitters, energy storage, solar distillation techniques, refrigeration and comfort heating, communication, heat engine, power systems evaluation, spectral properties of materials, and propulsion.

N-78623, v.2
AN ANALYSIS OF SOLAR ENERGY UTILIZATION.
VOLUME II, PART III - TECHNICAL ANALYSES - SECTIONS 1 THROUGH 6. J.H. Fisher. Feb. 1959. 340p.

Wright Air Development Center TR 59-17, v.2
Electro-Optical Systems, Inc.
Contract AF-33(616)-5564
Author

This is a technical analysis of flat plate solar collectors, concentrating solar collectors, photovoltaic converters, thermopiles and thermionic converters, energy storage systems, and analysis of solar distillation techniques.

1959 X9688/O-B/14
Power sources, Solar
Auxiliary power sources, Solar
Converters
Air Force project 7116
Air Force task 70189
11.11, 12.5, 12.3

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Daniels, Farrington, ed.
Solar energy research, edited by
Farrington Daniels and John A. Duffie.
University of Wisconsin Press, 1955.
xv, 290p.

1959 X9689/O-B/16
Power sources, Solar
Auxiliary power sources, Solar
Converters
Storage batteries
Distillation apparatus
Air Force task 70189
Air Force project 7116
11.11, 12.5-1, 12.1, 12.3

c.1 E

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1955

Association for Applied Solar Energy.
Proceedings of the world symposium on applied solar energy. 1955-
Menlo Park, Calif., Stanford Research Institute,
v. illus., ports. 29 cm.
Conferences sponsored in cooperation with Stanford Research Institute and the University of Arizona.

621.47
As7d

Association for Applied Solar Energy
A directory of world activities and bibliography of significant literature.
Edited by Jean Smith Jensen. 2d ed.
Special Supplement to Solar Energy.
Phoenix, Arizona, Association for Applied Solar Energy. 1959
275p.

1974

Comparative Evaluation of Solar, Fission, Fusion, and Fossil Energy Resources. Part 1: Solar Energy.

J. R. Williams.

Georgia Inst. of Tech., Atlanta. School of Mechanical

Engineering. 23 Jan 74, 122p NASA-CR-137242

N74-18721/2WE PCS9.25/MFS1.45

The utilization of solar energy to meet the energy needs of the U.S. is discussed. Topics discussed include: availability of solar energy, solar energy collectors, heating for houses and buildings, solar water heater, electric power generation, and ocean thermal power.

1974

N74-19711# Chicago Univ., Ill.
SOLAR CONCENTRATORS OF A NOVEL DESIGN

Roland Winston Mar. 1974 25 p refs

(EFI-74-21) Avail: NTIS HC \$4.25 CSCL 10A

A new principle for collecting and concentrating solar energy, the ideal cylindrical light collector has been invented. The collector is a trough-like reflecting wall light channel of a specific shape which concentrates radiant energy by the maximum amount allowed by phase space conservation. The ideal cylindrical light collector is capable of accepting solar radiation over an average 8-hour day and concentrating it by a factor of approximately 10 without diurnal tracking of the sun. This collector has a large acceptance for diffuse light. In fact, the efficiency for collecting and concentrating isotropic radiation, in comparison with a flat plate collector, is just the reciprocal of the concentration factor.

Author

SOLAR HEATING AND COOLING DEMONSTRATION ACT OF 1973. Ninety-Third Congress, Second Session, Report No. 93-769. Washington, DC: Committee on Science and Astronautics (1974). 43p. GPO.

The bill provides for the United States to accomplish the demonstration of the practical use of solar heating technology in three years utilizing current technology, and to accomplish the research, development, and demonstration of the practical use of combined solar heating and cooling technology within five years. Background, explanation, legislative aspects, cost and budget data, and committee considerations are given. (MCW)

N74-19604# Committee on Science and Astronautics (U. S. House).

H.R. 11864: SOLAR HEATING AND COOLING DEMONSTRATION ACT OF 1974. BACKGROUND AND LEGISLATIVE HISTORY

Washington GPO Feb. 1974 306 p refs Presented to Comm. on Sci. and Astronaut., 93d Congr., 2d Sess., Feb. 1974

Avail: NTIS Avail: Subcomm. on Energy.

The responses are reported of selected Federal agencies to requests, by the Committee, for information on current research in areas of solar energy. The nature of ongoing solar energy research, funding levels, and recommended areas for development are discussed. The legislative history of solar energy for heating and cooling. H.R. 11864 is included.

F.O.S.

(SLA-74-68) PROPOSAL TO NSF FOR SUPPORT OF SOLAR COMMUNITY SYSTEMS ANALYSIS. Stremberg, R. P.; Fidenburn, M. W.; Thunberg, S. (Sandia Labs., Albuquerque, N. Mex., (USA)). Feb 1974. Contract AT(29-1)-789. 49p. Dep. NTIS \$4.50.

Sandia Laboratories proposes that the National Science Foundation sponsor a program for more sophisticated systems analysis of solar energy systems. The analysis will be primarily aimed at the solar total energy concept, but it should also be applicable to other solar thermal applications. The effort will require the use of a flexible computer program that can control and manipulate individual component subroutines to determine their impact on the total system. The program will determine solar system costs and fossil fuel savings as compared with those associated with a conventional fossil fuel system. (48 references) (auth)

N74-19700*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
A PANEL FOR SELECTIVELY ABSORBING SOLAR THERMAL ENERGY AND THE METHOD FOR MANUFACTURING THE PANEL Patent Application

James R. Lowery, inventor (to NASA) Filed 5 Apr. 1974
21 p
(NASA-Case-MFS-22562-1; US-Patent-Appl-SN-458484) Avail: NTIS HC \$4.25; CSCL 10A

A panel for selectively absorbing solar thermal energy is reported that consists of a metallic substrate, a layer of bright metallic material carried on the substrate, and a solar thermal energy absorbing coating carried on the bright metallic material. A layer of zinc is interposed between the metal substrate and the layer of bright material, or the metallic substrate can be anodized for receiving the layer of bright metallic material. Also disclosed is the method for producing the coating which selectively absorbs solar thermal energy. NASA

FEASIBILITY OF SOLAR HEATING AND COOLING OF BUILDINGS. Weinstein, A.; Chen, C. S. Prof. Eng.; 44: No. 2, 28-32(Feb 1974).

The assurance of the availability of solar energy makes that factor more dominant than initial costs now. The concept for the utilization of solar energy is not new, but what is new is the development of systems, subsystems, and components of adequate performance and reliability that could be produced in volume at acceptable costs to meet the potential needs of a commercial market. Systems being developed for heating and cooling are discussed. Feasibility studies results will be presented in May 1974 for "proof-of-concept" experiments of sufficient scale in various building types and several regions of the country. (NCW)

SOLAR LAB USES SPACE-DERIVED EXPERTISE.
Aviation Wk & Space Tech., Feb.4,1974, p.56,57.

Honeywell, Inc. is sharing costs with the Nat. Sci. Foundation of a mobile solar heating and cooling laboratory whose technology stems in part from thermal coating work for spacecraft sponsored by the Air Force.

PLUGGING INTO THE SUN.

F.E. Bryson.
Machine Design, v.46, no.3, Feb.7,1974, p.20-25.

Although efficiencies are not yet high, the technology is available to convert sunlight directly into useful energy. The development could change the shape of your next house.

NSF GRANTS WESTINGHOUSE \$500,000 FOR PILOT SOLAR HEATING-COOLING SYSTEM.

Energy Digest, July 15,1974, p.245-247.

The first large building to be both air conditioned and heated with the help of sunlight will be the George A. Towns Elementary School located in Atlanta. Sunlight will provide about 60 percent of the energy needed by the school's domestic hot water supply, absorption air conditioning system and hot water heating system.

THE HYDROGEN ECONOMY MIAMI ENERGY (THEME) CONFERENCE.
Presented by The School of Engineering &
Environmental Design, Univ. Miami, Coral
Gables, Florida.
Sponsored by The National Science Foundation,
Defense Advanced Research Projects Agency,
and The School of Continuing Studies, Univ.
of Miami.
Miami Beach, Florida, Mar.18-20,1974.

A TOWER-TOP POINT FOCUS SOLAR ENERGY COLLECTOR

A. F. Hildebrandt, L.L. Vant-Hull, University of
Houston, Houston, Texas

Project SACS phase 1 report: Solar assisted gas
energy water heating feasibility for application in
see apartments California Inst. of Tech., Pasadena.
Environmental Quality Lab. DAVIS, E. S. JGR.
1973 47 PAGES REFS. Sponsored in part
by Southern Calif. Gas Co. EOL-BEEO-11 Avail:
Issued Activity
ENERGY POLICY, SOLAR HEATING, *SOLAR ENERGY
BUILDINGS, COST ESTIMATES, EQUIPMENT SPECIFICATIONS,
FEASIBILITY ANALYSIS, SOLAR COLLECTORS, SOUTHERN
CALIFORNIA, WATER C03 874-21675

(BNL-18734) SOLAR POWERED STEAM SUPPLE-
MENT FOR THE BNL STEAM PLANT. Cottingham, J. G.;
Green, G. K. (Brookhaven National Lab., Upton, N. Y. (USA)).
15 Mar 1974. 26p. Dep. NTIS \$4.50.

Solar energy converted to commercial steam can be distributed
and used by existing equipment to heat and cool buildings. This
forms a ready economical market for an otherwise expensive
energy source. Component designs and system plans are outlined
using an elevated boiler and reflectors that track the Sun. (auth)

TITLE: Formulation of a Data Base for the
Analysis, Evaluation and Selection of a Low
Temperature Solar Powered Air Conditioning
System, Quarterly Progress Report (Covering
the Period October 31, 1973 to January 31,
1974)

CORPORATE AUTHOR: University of Florida,
Engineering and Industrial Experiment Station
ADDRESS: Gainesville, FL 32611
PUBLICATION DESCRIPTION: Report No.
NSF/RANN/SE/GI39323/PR74/4, 184 p.

PUBLICATION DATE: 1974, January 31
SPONSOR: National Science Foundation, RANN Program
ABSTRACT: An extensive literature review is being
conducted and a considerable amount of data
are currently available as a result of this
effort. This review is to continue
concurrent with the analysis of the available
data. Contacts with industrial and research
organizations and consultants have been
maintained for advice and information. A
computer program has been developed for
analysis of the Libr/water system. Some of
the results of this program are contained in
the report. Another computer program
developed calculates solar insolation data
for latitudes from 24 degrees N to 64 degrees
N. (auth)

N73-32655*# National Aeronautics and Space Administration.
Lewis Research Center, Cleveland, Ohio.

FLAT-PLATE COLLECTOR PERFORMANCE EVALUATION.
THE CASE FOR A SOLAR SIMULATION APPROACH
F. F. Simon and Paul Harlamert 1973 21 p refs Presented
at Intern. Solar Energy Soc. Cleveland, 3-4 Oct. 1973
(NASA-TM-X-71427; E-7670) Avail: NTIS HC \$3.25 CSC1
038

A method is proposed for determining the performance of
flat-plate solar collector using a simulated sun. Collector test
variables that will help establish the basis for the indoor test
facility at the Lewis Research Center are discussed. The use of
the indoor testing should permit a standard test for the convenient
and accurate determination of collector performance. Preliminary
test results are reported as an example of the type of collector
performance data to be expected from the simulation approach.
Author

Solar heated and cooled office building for the
Massachusetts Audubon Society: Initial planning and
design Final Report Little (Arthur D.), Inc.,
Cambridge, Mass. Cambridge Seven Associates, Mass.
JUN. 1973 58 PAGES REFS. Prepared
jointly with Cambridge Seven Assoc. Sponsored by
Mass. Audubon Soc. C-75457 AVAIL- NTIS HC
\$6.00

*BUILDINGS, *SOLAR ENERGY ABSORBERS, *STRUCTURAL
ENGINEERING
ARCHITECTURE, CONSTRUCTION, COST ANALYSIS

C34 874-22602 6

N74-14499# Maryland Univ., College Park. Dept. of Mechanical Engineering.
PROCEEDINGS OF THE SOLAR HEATING AND COOLING FOR BUILDINGS WORKSHOP. PART 1: TECHNICAL SESSIONS, MARCH 21 AND 22
 Redfield Allen Jul. 1973 231 p refs Workshop held Washington, D. C., 21-23 Mar. 1973
 (Grant NSF GI-32488)
 (PB-223536/4GA; NSF-RA/N-73-004) Avail: NTIS HC \$3.00
 CSCI 13A

The proceedings contain thirty-six technical papers on solar energy for U.S. building applications areas: namely, solar collectors, energy storage, domestic hot water heating, energy conservation and insulation, solar air-conditioning, and systems for solar heating and cooling. Some foreign activities are also reviewed. Each technical paper is a report on: proposed research, on-going research, proposed systems, or operating systems. Questions and answers from the discussion periods are included, as is an agenda and list of attendees.
 GRA

N74-12684* Auburn Univ., Ala.
MARKET POTENTIAL FOR SOLAR HEATING AND COOLING IN BUILDINGS
In its TERRASTAR: Terrest. Appl. of Solar Technol. and Res.
 Sep. 1973 13 p refs (For availability see N74-12674 03-34)
 CSCI 20M

The use of solar heating and cooling for buildings as a method of conserving fossil fuels is discussed. The residential and commercial end use consumption of energy is tabulated. A survey to project the energy requirements for home and industry heating and cooling is developed. The survey indicates that there is a market potential for solar heating and cooling of buildings. A prediction of three to five billion dollars per year as the potential for solar heating and cooling is made.
 Author

N74-12685* Auburn Univ., Ala.
STRATEGY FOR SOLAR HEATING AND COOLING IN BUILDINGS
In its TERRASTAR: Terrest. Appl. of Solar Technol. and Res.
 Sep. 1973 159 p refs (For availability see N74-12674 03-34)
 CSCI 20M

The types of solar energy heating and cooling equipment for use with buildings are discussed. The steps from manufacturing to equipment installation are identified. A feasibility study for the use of solar energy was conducted. The study determined the technical, environmental, economic, sociological, political, and strategic aspects of solar heating and cooling.
 Author

N74-12679* Auburn Univ., Ala.
SOLAR HEATING AND COOLING BUILDINGS
In its TERRASTAR: Terrest. Appl. of Solar Technol. and Res.
 Sep. 1973 28 p refs (For availability see N74-12674 03-34)
 CSCI 20M

Sunshine is available in differing amounts everywhere in the world and the easiest method of capturing it is by absorption in the form of thermal energy (heat). Therefore, it is logical to utilize it directly in the heating and cooling of buildings and avoid losses that would occur by conversion to some other form. It may be emphasized that of the total energy consumed annually in the U.S., about 25% is used for heating and cooling in buildings. It is generally agreed that of all the possible widespread uses of solar energy, this application has the highest probability of success in the near term. Although there are significant uncertainties associated with some technological and economic aspects, they do not loom as large as those associated with other potentially significant applications, such as electrical power generation. It may, however, be noted that solar electrical power generation at the building site, or at a centralized station is an excellent long term prospect. Approximately 25 experimental solar heated structures have been built in various parts of the world.
 Author

Modeling of Solar Heating and Air Conditioning.

W. A. Beckman, and J. A. Duffie.

Wisconsin Univ., Madison. Engineering Experiment Station.
 31 Jul 73. 20p NSF-RA/N-73-088, NSF-RANN/SE/GI-34029/PR-73-2

PB-228 877/WE PCS4.00/MF\$1.45

Processes for application of solar energy to heating, cooling and service hot water supply of buildings are comprised of components which function in interrelated manner. The components include: solar energy collector, storage unit, service hot water facility, air conditioner, space heater, auxiliary energy source, associated controls and the building. In this work, the transient thermal performances of these components is mathematically modeled, the models are programmed, and the complete system is 'operated' in particular climates using appropriate meteorological data. A first system has been modeled based on water heating collectors, water storage tanks, lithium bromide-water absorption cooler (with cooling tower) and associated equipment. It has 'operated' on a residential type building in Albuquerque climate. The thermal analysis shows integrated energy supplied from solar and auxiliary energy through a year. Based on this thermal analysis a preliminary cost analysis is made to compare solar and conventional systems.

1973

N74-11787# Committee on Science and Astronautics (U. S. House).

SOLAR ENERGY FOR HEATING AND COOLING

Washington GPO 1973 295 p refs Hearings before Comm. on Sci. and Astronaut., 93d Congr., 1st Sess., No. 13, 7 and 12 Jun. 1973

Avail: Subcomm. on Energy

A Congressional hearing was conducted to examine the use of solar energy for heating and cooling. Examples of various solar energy conversion systems are illustrated and described. The subjects discussed are: (1) the status of solar energy technology, (2) market factors, (3) technology transfer, and (4) the benefits of using solar energy for heating and cooling buildings.

P.N.F.

Solar Heating and Cooling Demonstrations Act
Committee on Science and Astronautics (U. S. House). Washington GPO 1974 510 PAGES
REFS. Hearings on H.R. 10952 et al. before Comm. on Sci. and Astronaut., 93d Congr., 1st Sess., No. 24, 13-15 Nov. 1973 GPO-27-370 Avail:

Subcomm. on Energy

*BUILDINGS, *CONGRESS, *COOLING SYSTEMS, *SOLAR ENERGY CONVERSION, *SOLAR HEATING ENERGY POLICY, *FEASIBILITY ANALYSIS, *HEAT PUMPS, *PERFORMANCE TESTS, *PROCEEDINGS, UNITED STATES OF AMERICA

C03 B74-21603 0

TITLE: SAV High-Speed Cylindrical Solar Water Heaters

CORPORATE AUTHOR: Fred Rice Productions Inc.

ADDRESS: 6313 Peach Ave., Van Nuys, CA

PUBLICATION DESCRIPTION: Installation and operating instructions, 8 p.

PUBLICATION DATE: 1973, July

ABSTRACT: A detailed description is given of a patented water heater, for sale as a complete unit. This is a cylindrical, rather than a flat plate, collector and water storage is an integral part of the unit. On a sunny day, a 10 gallon unit will heat 20 gallons of water up to 50 degrees C. Maximum pressure is limited to 7.5 psi. (JHC)

AVAILABILITY: Fred Rice Productions Inc., 6313 Peach Ave., Van Nuys, CA

1973

TITLE: The Solar/Sonic Flip-Top Mobile Home: A New Concept in Recreational Living

CORPORATE AUTHOR: Fred Rice Productions Inc.

ADDRESS: 6313 Peach Avenue, Van Nuys, CA 91401

PUBLICATION DESCRIPTION: 20 p. report

PUBLICATION DATE: 1973

ABSTRACT: This brochure describes an unusual mobile home, especially designed for use in remote locations. The unit is 12 ft. x 14 ft. when traveling, and unfolds to give a conventional appearance with sloping roof. The south roof contains a skylight and a solar heat collector. Solar cells with storage batteries power an emergency lighting system. The water tank is contained in a insulated chimney. The construction is chiefly metal and plastic panels. (JHC)

N74-13638# California Univ., Berkeley, Lawrence Berkeley Lab.

CALCULATIONS ON A SOLAR ENERGY SYSTEM

R. M. Graven 8 Mar. 1973 33 p refs Presented at the Intern. Meeting on the Solar Energy Soc., Cleveland, 3 Oct. 1973

(Contract W-7405-eng-48)

(LBL-1773; Conf-731002-1) Avail: NTIS HC \$3.75

A computer program has been used to calculate the amount of energy which can be extracted from a flat plate solar collector. The computations consider latitude, heat loss, daily temperature range, percent cloud cover, sun angle, etc. to determine the feasibility of home heating for an angularly adjustable solar collector in the Northern Hemisphere. The program also calculates the energy available from a solar-earth heat pump. The influence of design parameters and the feasibility of using solar energy to generate heat and electricity for a small single family residence have been considered.

Author (NSA)

N74-16513# Little (Arthur D.), Inc., Cambridge, Mass. Engineering Sciences
ENERGY CONSERVATION WITH SOLAR CLIMATE CONTROL

Peter E. Glaser 14 Nov. 1973 9 p Presented to Subcomm. on Energy of the Comm. on Sci. and Astronaut., US House of Representatives, Washington, 14 Nov. 1973

Avail: NTIS HC \$3.00

The use of solar energy for climate control is discussed, with emphasis on solar heating and cooling of buildings. Government/industry relations are discussed in terms of taking action and supplying the market for solar climate control systems. The components of these systems are listed.

K.M.M.

E92

1973

H. G. LORSCH, National Center for Energy Management and Power, University of Pennsylvania, Philadelphia, Pennsylvania 19104, U.S.A.

The use of solar energy for residential space heating: *Energy Conversion* 13, 1-5 (1973).

Summary—Space and hot water heating accounts for 20 per cent of United States energy consumption, residential space heating alone requires 12 per cent. In an attempt to help alleviate the energy shortage, research has been performed on using solar energy for residential space heating. Various solar collectors and thermal energy devices were investigated. Using a suitable solar heating system to supplement a conventional gas furnace, fuel savings in excess of 40 per cent were obtained by computer simulation for Washington, D.C. weather. It is estimated that solar heating can become economically competitive by 1980, sooner if government regulations encourage its use.

Key words: Solar heating thermal energy storage space heating fuel consumption energy shortage

AN INVESTIGATION OF THE CONTRIBUTION OF SOLAR ENERGY IN HEATING GREENHOUSES IN QUEBEC.

T.A. Lawand, et al.

J. Engineering for Power, v.95, no.2, Ser.A, p.114-118.

ENERGY, TECHNOLOGY, AND SOLAR ARCHITECTURE.

Hay, H. R. (Sky Therm Processes and Engineering, Los Angeles). Mech. Eng., 95: No. 11, 18-22 (Nov 1973).

An evaluation of a diurnal energy air conditioning system funded by the U. S. Department of Housing and Urban Development pertains to a "sky therm" house to be built in California. Solar architecture is compatible with the objectives of conservation groups in energy and in land use. It can reduce by 70% the residential power needs in most of the Southwest through buildings whose materials, structural elements, landscaping, and operation are designed to take maximum advantage of night-sky cooling and direct use of solar energy for space and water heating. All aspects of the project are described. (MCW)

THE SOLAR HOUSE AND ITS PORTENT.

K.W. Boer.

Chemtech, July 1973, p.394-400.

The solar home now seems able to shave peak loads by controlling the climate generating its electricity.

SOLAR HEATING AND COOLING: UNTAPPED ENERGY PUT TO USE

KEY WORDS: Architecture; Buildings; Cooling; Economics; Energy; Heating; Solar energy; Solar energy concentrators

ABSTRACT: The heating of buildings by solar energy is now technically feasible and nearly economically competitive. The technical aspect has already been demonstrated by numerous, successful solar buildings. Lof and Tybout have analyzed the economics and have indicated that a substantial cost savings could be obtained by adding cooling to the load on the solar system, thereby using the same equipment all year long at very little extra cost. Consequently, a large number of architects and engineers are now working on a variety of structures with solar heating and cooling systems. While the prospects of using solar energy for power generation are still uncertain, clean solar heating and cooling systems have now become feasible and realistic methods of conserving energy and easing the energy crisis.

REFERENCE: Lof, George O.G., and Ward, Dan S., "Solar Heating and Cooling: Untapped Energy Put to Use." CIVIL ENGINEERING—ASCE, September, 1973, pp. 88-92

TITLE: Conservation and Better Utilization of Electric Power by Means of Thermal Energy Storage and Solar Heating, Phase III - Progress Report

AUTHOR: Yeh, H.

CORPORATE AUTHOR: Pennsylvania, University of

ADDRESS: Philadelphia, PA 19174

PUBLICATION DESCRIPTION: Report No.

ACF/NAEP/SE/S127976/PR73/1, 30 p.

PUBLICATION DATE: 1973, March

SPECIFIC: National Science Foundation, RANN Program

ABSTRACT: This report describes the progress made in the first three months of 1973 on studies of off-peak air conditioning, residential heating with solar energy, and materials for thermal energy storage. (APG)

COST OF HOUSE HEATING WITH SOLAR ENERGY

G.O. G. LÖF* and R. A. TYBOUT†

(Received 7 February 1972)

Abstract— There has long been a need for a practical method of predicting the true cost of heating a house with solar energy and designing the heating system (solar and auxiliary) to achieve the minimum total annual heating cost possible under the particular climatic, geographic, and residential characteristics involved. Rough approximations based on various types of averaged values of weather and seasonal variables have previously been developed, but the reliability of such methods and results is open to question. The authors have therefore made a rigorous analysis of projected solar heating costs in eight U.S. cities and have optimized the heating system design in each location.

The analysis involved the use of a high speed computer and approximately 400,000 hourly observations in eight cities of radiation, temperature, wind, solar altitude, cloud cover, and humidity. Equations for performance of flat plate solar collectors and sensible heat storage systems were developed and programmed with the above weather variables and with eight design parameters comprising house size, collector size, storage size, collector tilt, number of transparent surfaces in collector, hot water demand, insulation on storage unit, and thermal capacity of collector. Capital and operating costs were quantitatively related to heating system design parameters, and the values of all design variables which yielded lowest annual heating cost in each city were then selected.

The findings are presented in the form of two tables and ten graphs, showing heating costs as functions of various design and location factors. The relative importance of each factor is discussed, and the overall costs of solar heating are compared with the costs of conventional heat supply in each location. The method for designing the least-cost combination of solar and conventional heat supplies is also shown, and an example of the use of the method is presented.

Solar Energy, 1973, Vol. 15, pp. 27-39. Pergamon Press. Printed in Great Britain

SOLAR HOUSES/HEATING AND COOLING PROGRESS REPORT

HARRY E. THOMASON,* and HARRY JACK LEE THOMASON, JR.*

(Received 31 March 1971; in revised form 14 June 1972)

Abstract— Performance data on seven solar homes are given. Solar Homes No. 1, 2, 3, and 4 are near Washington, D.C., 39° north latitude, where about half of the winter days are cloudy and temperatures drop far below freezing, sometimes to 0°F. These houses are described in the book *Solar Houses and Solar House Models* by Harry E. Thomason, published by Edmund Scientific Company, Barrington, New Jersey 08007. Edmund Scientific Co. also publishes *Solar House Plans*, for building a house similar to Solar House No. 1, with improvements.

1973

N73-28978*# Scientific Translation Service, Santa Barbara, Calif.
LUMIDUC ARCHITECTURE
Guy Rottier Washington NASA 29 Jun. 1973 11 p Transl.
into ENGLISH from the French report Bull-22
(Contract NASw-2483)
(NASA-TT-F-14983: Bull-22) Avail: NTIS HC \$3.00 CSCL 138

A new concept of architecture for urban design is discussed. The design enables solar rays to be captured and directed by means of reflection through channels to the interior of a dwelling, thereby foregoing the necessity of rooms having an outside exposure for solar illumination. Author

SOLAR ENERGY IN AUSTRALIA.

Nature, Vol. 246, Nov. 16, 1973, p. 118.

Solar heating of water is already in use to the extent of saving 5,000 T. of coal/yr. Plans for the future.

SOLAR HOMES: A guide to developments in solar heating and cooling of residential units, including solar heat collectors, costs, floor planning, locations, and projections for future developments. 61 pages. (Solar House Heating & Air Conditioning Systems...Comparisons and Limitations, Book No. 9463, By H.E. and H.J.L. Thomason, available at \$5.00 per copy from Edmund Scientific Co., 555 Edscorp Bldg., Barrington, N.J. 08007.)

SOLAR ENERGY UTILIZATION FOR HEATING AND AIR CONDITIONING.

1972

R.R. Avezov, et al
Applied Solar Energy, v.8, no.3-4, 1972, p.120-28.

Paper provides a detailed analysis of foreign and Soviet experimental data in the utilization of solar energy for heating and air conditioning and compares the climate in the southern regions of the USSR with that of the northern and central states of the USA.

1972

TITLE: A Model for Optimizing Solar Heating Design
AUTHOR: Lof, G.O.G.; Tybout, R.A.
CORPORATE AUTHOR: Ohio State University
ADDRESS: Columbus, OH

PUBLICATION DESCRIPTION: Paper No. 72-WA/Sol-8, contributed by the Solar Energy Applications Group of The American Society of Mechanical Engineers for presentation at the Winter Annual Meeting, New York, NY, November 26-30, 1972, 5 p.

PUBLICATION DATE: 1972

SPONSOR: Resources for the Future, Inc.; Ohio State University

ABSTRACT: Rational design of a residential solar heating system requires an analysis of the varying heat demand in relation to the fluctuating solar energy supply at a given location. These data can be used in equations which correlate system performance with design features such as size of solar collector and storage, collector slope, and other parameters. Designs for minimum solar heating costs can then be selected. An analysis of this type has been made for eight U.S. cities, the results of which were recently published, but the development of the energy transfer equations and the details of their solution were not included. The present paper is a presentation of the technical basis for the computation of hour-by-hour performance of a heating system comprising a solar collector, heat storage unit, and auxiliary heat supply, to meet the demand for house heating and water heating. (Auth)

AVAILABILITY: The American Society of Mechanical Engineers, United Engineering Center, 345 East 47th St., New York, NY 10017 (\$3.00 per copy, \$1.00 to ASME members)

529

SOLAR HEAT UTILIZATION IN RESIDENTIAL HEATING

SYSTEMS Ph.D. Thesis

Abdullah Osted-Hosseini 1972 216 p

Avail: Univ. Microfilms Order No. 73-13447

A performance model of a solar collector was created in order to determine the useful heat which may be obtained from a flat plate solar collector. The model permits the calculation of the efficiency of a flat plate solar collector as a function of interplate spacing, incident solar radiation, number of plates, emissivity and absorptivity of the absorber, angle of incidence and other engineering variables. The model was used to compare different collector designs. The results are presented in graphical form suitable for system performance determination. A series of experiments yielded results within 5% of the analytical predictions. The computer program can predict the efficiency of solar collector as a function of date, time, location, and orientation of the collectors, the thermal and optical properties of glass and absorber plates, and the temperatures of the outside glass plate and the absorber plate. Weather data can be fed into the computer along with this program to obtain the yearly yield of solar heat.

Dissert. Abstr.

TITLE: Solar Heating Systems Analysis

AUTHOR: Lorsch, R.G.

CORPORATE AUTHOR: University of Pennsylvania, National Center for Energy Management and Power; University of Pennsylvania, Towne School of Civil and Mechanical Engineering

ADDRESS: Philadelphia, PA 19104

PUBLICATION DESCRIPTION: Report No.

NSP/RANN/SE/GI27976/TR72/19

PUBLICATION DATE: 1972, November

SPONSOR: National Science Foundation, RANN Program

ABSTRACT: After a critical review of past work on solar heating and thermal storage (TPS), the architectural, engineering, and economic requirements for solar heated housing were defined. A residential solar heating system was conceived which (1) includes conventional heating as a back-up system and (2) uses conventional control components. TPS through latent or sensible heat is possible, and either liquid or gaseous heat transfer loops can be employed. Using a residential development currently under construction, a computer analysis was performed to determine possible heating fuel savings for various sizes of solar collectors and TPS devices. Savings of 50% appear practical for a Washington, DC location. Fuel cost savings as a consequence of capital investment in a solar heating system were optimized for present (1972) and near-term future economic conditions. (Auth)

(NP-19784) INFLUENCE OF AZIMUTHAL ORIENTATION ON COLLECTIBLE ENERGY IN VERTICAL SOLAR COLLECTOR BUILDING WALLS. Lorsch, H. G.; Niyogi, B. (Pennsylvania Univ., Philadelphia (USA). National Center for Energy Management and Power). Aug 1971. 22p.

The requirement of southern exposure for the collector seriously constrains the architectural freedom of planning and designing solar-heated buildings. Work was performed to determine the reduction in available energy from vertical solar collectors that do not face due south. For median US latitude and the critical winter months of December and January, it was found that a 23° deviation from the exact southern orientation produces only a 5% energy penalty, a 33° deviation a 10% penalty. Detailed graphs are presented showing energy penalties as a function of calendar month, azimuth, and latitude. (auth)

TITLE: Conservation and Better Utilization of Electric Power by Means of Thermal Energy Storage and Solar Heating, Phase II - Progress Report

AUTHOR: Altman, N.

CORPORATE AUTHOR: Pennsylvania, University of ADDRESS: Philadelphia, PA 19174

PUBLICATION DESCRIPTION: Report No.

NSP/RANN/SE/GI27976/72/4, 70 p.

PUBLICATION DATE: 1972, December

SPONSOR: National Science Foundation, RANN Program ABSTRACT: Concern for maintaining reliable and economical energy supplies and for supplying electrical power demands has led to the

examination of techniques for better utilization of existing resources. The use of thermal energy storage and solar energy to provide comfort conditioning by methods which consume less fuel and require less peak power is to be studied. One task of the project is the investigation of off-peak air conditioning systems which perform much of the power consuming function at night. This would reduce peak daytime loads on summer peaking utilities. A second project task is the use of solar energy for heating residential buildings. This would reduce fuel consumption. Both of these systems involved heat storage to deliver the required commodity, heating or cooling, subsequent to the time when the commodity is best obtained. This logically led to a third project task: the investigation of materials for storing thermal energy. The economic conditions required for successful introduction of the novel systems are to be defined, and the effect of such systems on electric utilities are to be investigated. (Auth, Objectives)

N73-17911* Lockheed Missiles and Space Co., Huntsville, Ala. Research and Engineering Center.

THE DEVELOPMENT OF A RESIDENTIAL HEATING AND COOLING SYSTEM USING NASA DERIVED TECHNOLOGY Mark J. O'Neill, A. J. McDaniell, and W. H. Sims Nov. 1972 98 p refs

(Contract NAS8-25986)

(NSA-CR-124063; LMSC/HREC-D306275; HREC-5986-3) Avail: NTIS HC \$7.00 CSCL 20M

A study to determine the technical and economic feasibility of a solar-powered space heating, air-conditioning, and hot water heating system for residential applications is presented. The basic system utilizes a flat-plate solar collector to process incident solar radiation, a thermal energy storage system to store the collected energy for use during night and heavily overcast periods, and an absorption cycle heat pump for actually heating and cooling the residence. In addition, heat from the energy storage system is used to provide domestic hot water. The analyses of the three major components of the system (the solar collector, the energy storage system, and the heat pump package) are discussed and results are presented. The total system analysis is discussed in detail, including the technical performance of the solar-powered system and a cost comparison between the solar-powered system and a conventional system. The projected applicability of the system to different regions of the nation is described.

Author

PERFORMANCE OF THE BRISBANE SOLAR HOUSE*

NORMAN R. SHERIDAN†

(Received 5 January 1972)

Abstract—A house with an absorption air conditioning system operated by flat-plate solar collectors has been built in Brisbane, Australia. After briefly describing the house and equipment, the paper gives the performance of the house for a typical clear summer day. It is suggested that the equipment performance should be adequate for the air conditioning of houses in the Australian tropics where reliable summer insolation is available. However, the results of a cost study of various types of air conditioned houses for the Australian tropics show that solar air conditioning is only marginally economic.

1971

N73-10976# Pennsylvania Univ., Philadelphia. Towne School of Civil and Mechanical Engineering.

CONSERVATION AND BETTER UTILIZATION OF ELECTRIC POWER BY MEANS OF THERMAL ENERGY STORAGE AND SOLAR HEATING Interim Report, 1 Feb. - 1 Jul. 1971

Manfred Altman 1 Oct. 1971 265 p refs (Grant NSF GI-27976)

(PB-210359; UPTES-71-1) Avail: NTIS HC \$6.75 CSCL 13A

A project to investigate the application of heat and coolness storage for comfort heating and air conditioning was initiated. Inexpensive salt hydrates exhibiting phase change temperatures between 40 F and 60 F were found appropriate with use of off-peak generation of coolness for storage and subsequent use during peak demand periods to supplement or replace electrically powered air conditioning units. Other inexpensive salt hydrates, with phase change temperatures of 89 F to 195 F were found for use as heat storage materials with solar heat collectors and off-peak electric heating units. A feasibility demonstration of the off-peak air conditioning system was built and successfully tested.

Author (GRA)

Tybout, R. A. and Lof, G. O. G., "Solar House Heating," *Natural Resources Journal*, 10, (2), p. 268-326, April 1970.

N74-15777# Army Foreign Science and Technology Center, Charlottesville, Va.

SOME RESULTS OF TESTING OF A SOLAR WATER HEATING INSTALLATION DURING THE HEATING SEASON

G. Ya. Umarov, R. A. Zakhidov, and R. R. Avezov 31 Oct. 1972 4 p Transl. into ENGLISH from *Geliotekhnika* (USSR), no. 4, 1970 p 85-86

(AD-754628; FSTC-HT-23-1011-72) Avail: NTIS CSCL 13/1

An experimental investigation of solar water heating plant with operating surface 2 sqm, mounted at the angle 50 degrees with the horizon are given. The possibility and expediency of solar energy application as a low potential heat source for the heating pump in heating regime are described. Author (GRA)

TECHNICAL NOTE

Design of a new Solar-Heated House using Double-Exposure Flat-Plate Collectors

H. H. SAFWAT† and A. F. SOUKA‡

(Received 21 April 1969; in revised form 10 August 1969)

INTRODUCTION

THE HEATING system of a ranch-type five-room house has been designed utilizing the energy of the Sun. The house, Fig. 1, has a floor area of 2500 ft² and is situated at a latitude of 30°N at Giza, Egypt. The walls are made of stone existing at the site, while the roof is built of reinforced concrete. The solar heating system is based upon the use of double-exposure, flat-plate collectors [1, 2, 7]. For the sake of simplicity a floor panel arrangement is used for space heating, and an auxiliary electric immersion heater is provided to complement the Sun's energy under adverse weather conditions. An insulated hot water tank is employed as the means of low-temperature heat storage. Figure 2 shows the flow diagram of the system.

The climate at Giza, which is a suburb of Cairo, is characterized by long hours of sunshine. This, coupled with the fact that the temperature, in the winter, rarely falls below 50°F during the day, makes the use of energy of the Sun for house heating attractive and feasible. The Giza Weather Bureau published data [3] indicate that the heating season extends between November and March.

Solar Energy, Vol. 12, pp. 379-385. Pergamon Press, 1969. Printed in Great Britain

Hygienic Clean Winter Space Heating with Solar and Hydroelectric Energy Accumulated During the Summer and Stored in Insulated Reservoirs

ERNST SCHÖNHOLZER*

(Received 30 January 1968; in revised form 15 September 1968)

INTRODUCTION

WINTER air pollution in our cities is currently so severe that the search for hygienic methods of space heating demands the most urgent attention. The best solution would be to install, in each city apartment block, well-insulated heat accumulators of great size which could be charged with energy from natural sources such as solar energy during the daytime and surplus hydroelectric energy at night. It is recognized that the capital cost would be high, but this could be reduced to a sufficiently reasonable level, by careful attention to design details, to enable the city residents to enjoy the healthier unpolluted atmosphere.

When one realizes that each person inhales about 26,000 times a day, nobody can deny that there are urgent reasons for improving the condition of the air of our cities. In spite of the very high first costs, it is instructive to indicate the substantial thermodynamic possibilities associated with the heat-storage capacity of a large, low-grade heat accumulator of a given insulating capacity and quality, which stores available summer-time energy for winter space heating.

SIMULATION AND OPTIMIZATION OF SOLAR COLLECTION AND STORAGE FOR HOUSE HEATING*

H. BUCHBERG and J. R. ROULET†

(Received 21 February 1968)

Abstract—The design of combined solar collection and storage systems for house heating requires careful integration and optimization to minimize unfavorable economics. Because the environmental factors are highly variable with time, hourly performance over a season must be considered to accurately assess economic problems. This study comprises annual simulation of system performance including the house, a flat plate solar collector, a water heat storage unit and an auxiliary heater, and the optimization to achieve a maximum allowable collector cost. Actual weather data for a design year stored on magnetic tape as hourly values are utilized in the study. The digital computer programs developed to make this study possible include a solar irradiation program, an implicit finite difference thermal analyzer program to calculate house heat load, a system simulation program utilizing the hourly weather, heat load and collector performance information to establish the state of the system at hourly intervals over a 1-yr period and an optimization program utilizing the 'pattern search' technique.

Three modes of operation were investigated:

1. Maintenance of an upper and lower bound to the storage water temperature by means of the cessation of solar collection and utilization of auxiliary heating, respectively.
2. Use of auxiliary heat to maintain a minimum storage water temperature but starting when the water temperature drops to within a specified increment of the minimum temperature.
3. Use of auxiliary heat directly, allowing the storage water temperature to drop below the minimum value.

A design optimization study utilizing annual weather data for the Fresno, California, area indicated a maximum allowable cost of approximately \$1.00/ft² for the solar collector. An auxiliary heater was needed to provide heat during long overcast and peak heat load periods. Savings resulting from a solar collection system were accountable only by the reduction of fuel consumption. Some savings in auxiliary heater capacity are possible by using the storage system to suppress peak heating loads through distribution over longer periods.

74Y30183 1967 ISS 00 JPLIG.446 621.471 IC-17-294879
LOW TEMPERATURE ENGINEERING APPLICATION OF SOLAR ENERGY. EDITED BY
RICHARD C. JORDAN.
AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING
ENGINEERS. TECHNICAL COMMITTEE ON SOLAR ENERGY UTILIZATION.
AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING
ENGINEERS NEW YORK, VII, 78 P. ILLS. 28 CM.
INCLUDES BIBLIOGRAPHIES.
LC SOLAR ENERGY -- ADDRESSES, ESSAYS, LECTURES. SOLAR HEATING --
ADDRESSES, ESSAYS, LECTURES.
ADDED JORDAN, RICHARD CHARLES, 1909- ED.
MAIN-CORP TRACE-IJIL*AUTH# CAILG BY-LC

1966

EXPERIENCE WITH SOLAR HOUSES.

H.E. Thomason.

Solar Energy, v.10, 1966, p.17-26.

Since 1959 four solar houses have been constructed by the author in the Washington, D. C. area. This report is primarily concerned with status of the solar heating, air conditioning, and water-heating system in the first house after about 6 years of service. Inspection of the heat storage bin shows no deterioration. The plumbing system has proved satisfactory and has required only minor repairs. The standby oil-heating system has needed only minor repairs. The collector glazing materials were deteriorating and were completely replaced at the end of 5 years. Rooftop evaporative cooling at night, while satisfactory most of the time was inadequate at others. After two years a low-power refrigerating compression system was substituted. The solar reflector-flux intensifier installed on the second house remains in good condition after 3½ years, but its reflective surface is somewhat dulled and is less efficient than when new. The experience to date, in short, is that no major flaw in design or construction has shown up.

CM-115,298

1962

EXPERIMENTAL STUDY OF A LiBr-H₂O ABSORPTION AIR CONDITIONER FOR SOLAR OPERATION. R. Chung, G.O.G. Lof and J.A. Duffie, U. of Wisconsin. (Presented at the Winter Annual Meeting, New York, N.Y., Nov.25-30,1962).

American Society of Mechanical Engineers

Paper

62-WA-347

Lithium bromide - water
Air conditioning apparatus
Power sources, Solar

13

P-8-18-64

N-99511

PROGRESS IN SPACE HEATING WITH SOLAR ENERGY. C.D. Engebretson and N.G. Ashar, Mass. Inst. of Tech. (For presentation at ASME winter annual meeting, New York, N.Y., Nov.27-Dec.2,1960). 9p.

American Society of Mechanical Engineers

Paper

60-WA-88

The MIT Solar House IV was designed and built to extract part of its space heating and hot-water load from the sun. This report discussed the house and its energy collection system, heating system, instrumentation, mode of operation, heating system operation, and energy collection system operation.

1960 L 2725/R-B/8-9-61/9

Heating equipment

Solar collectors

Power sources, Solar

11.11, 12.3

73V14521 1962 ISS OC TJ81C.S58 697.93 LC-72-1856C
A/SMOLENIEC, S.

UTILIZATION OF SOLAR ENERGY FOR AIR CONDITIONING: INAUGURAL LECTURE,
BY S. SMOLENIEC.

WITWATERSRAND UNIVERSITY PRESS, JOHANNESBURG, 29 P. ILLUS. 23 CM.

"DELIVERED 21 SEPTEMBER, 1960." BIBLIOGRAPHY P. 29.

LC SOLAR ENERGY. AIR CONDITIONING.

MAIN-AUTH TRACE-TITL* CATLG BY-LC

/ / PUBL IN SOUTH

Lof, G. O. G., et al, "Solar Energy Utilization for House Heating", Report no. PB 25375, Dept. of Commerce, Wash. D.C., 1946.

END

1974

1974

The Shallow Solar Pond Energy Conversion System: An Analysis of a Conceptual 10-MWe Plant.

A. F. Clark, J. A. Day, W. C. Dickinson, and L. F. Wouters.
California Univ., Livermore. Lawrence Livermore Lab. 25

Jan 74, 31p

UCRL-51533 PC\$4.00/MF\$1.45

A shallow solar pond system appears to be the most cost effective way to produce large scale electric power from solar energy. A shallow solar pond system can be built using materials, fabrication techniques, and geometries that are presently used on a large scale in U. S. industry. A 10 MWe plant built in the Southwest would require a total area of about 2.5 sq km (approximately one sq mi) and could provide power for a community or a manufacturing process. The estimated busbar cost of electricity (in 1973 dollars) for a shallow solar pond system, which could come on line in as short a time as 5 to 7 years, is 27 mills/kWh. It is projected that this cost could be reduced by almost half with the development of improved and cheaper plastics and more efficient turbines. (Modified author abstract)

1974-19706*# National Aeronautics and Space Administration.
Lewis Research Center, Cleveland, Ohio.

CLEAN FUELS FROM BIOMASS

Y. Y. Hsu 1974 23 p refs Presented at the 10th Southeastern Seminar on Thermal Sci., New Orleans, 11-12 Apr. 1974 (NASA-TM-X-71538; E-7945) Avail: NTIS HC \$4.25 CSCI 20M

The feasibility of converting biomass to portable fuels is studied. Since plants synthesize biomass from H₂O and CO₂ with the help of solar energy, the conversion methods of pyrolysis, anaerobic fermentation, and hydrogenation are considered. Cost reduction methods and cost effectiveness are emphasized. G.G.

1974

(UCID-16446) GUIDE FOR CALCULATING COLLECTION EFFICIENCY FOR THE SHALLOW SOLAR POND (APPLICABLE FOR ANY HORIZONTAL FLAT PLATE SOLAR COLLECTOR). Dickinson, W. C.; Neifert, R. D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Feb 1974. Contract W-7405-Eng-48. 44p. Dep. NTIS \$4.25.

The collection efficiency of a solar collector system was calculated by a method of Hottel and Whillier and Liu and Jordan. The method calculates the hourly rate of energy collection and the long term on monthly average collection efficiency based upon monthly average daily solar insolation data and daytime temperatures obtained from Weather Bureau data. The method provides the most realistic values of collection efficiency that can be obtained for a given collector system in a given location. Not only is the monthly variation taken into account but also the statistical effect of bad weather. The "Solar" computer program was written to calculate average hourly values of collected heat and average daily values of collection efficiency. (MCW)

A74-27322

Solar energy by photosynthesis. M. Calvin (California, University, Berkeley, Calif.). Science, vol. 184, Apr. 19, 1974, p. 375-381. 32 refs. AEC-sponsored research.

Discussion of the chemical, energetic and economic aspects of solar-to-electric energy conversion by photosynthesis. Several model systems of photosynthetic solar energy conversion are described in detail, including photochemical hydrogen production, carbohydrate and polyisoprene production, and oxygen production by photolysis of binuclear manganese compound. The photoelectric membrane is considered as an agent in the primary quantum conversion event in the green plant. It is anticipated the conversion of carbohydrates from cane or beets through alcohol-to-hydrocarbon fermentation may become economic due to improved fermentation technology and increasing costs of hydrocarbon recovery from fossil sources. V.Z.

1974

TITLE: Proposed Program and Budget for Photovoltaic Systems.
AUTHOR: Eldridge, P.R.
COMPANIE: ANTARR: NINE COY.
ADDRESS: Westgate Research Park, McLean, VA 22101
PUBLICATION DESCRIPTION: Report No. NSF/RA/N-73-11, 1st p.
PUBLICATION DATE: 1974, February
SPONSOR: National Science Foundation
ABSTRACT: This document provides a description of the goals, suggested approach, funding, priorities for a total of 42 tasks, performed under a total of 25 projects, that would be conducted during the course of the proposed program for photovoltaic systems that is contained in this document. This proposed program has been designed to demonstrate, by basic and applied research and the technical proof-of-concept experiments, the feasibility, economic viability, environmental impact, sociological desirability, institutional constraints, and potential utilization of photovoltaic systems that would derive replaceable energy from the sun to help satisfy future U.S. energy needs. (auth)

A74-23842 # Photo-electric generators. W. Palz (Centre National d'Etudes Spatiales, Paris, France). *Industries Atomiques et Spatiales*, vol. 18, Jan.-Feb. 1974, p. 21-26.

This is an introductory article covering the field of solar photoelectric generators. A description is first given of the various semiconductor materials which can be used in the manufacture of solar batteries. It is then given some insight into the technology currently used in the making and the installing of solar batteries. And finally a summary is given of the principal fields of application of the photoelectric converters. It is to be borne in mind that space vehicles are almost exclusively powered by solar photoelectric generators. On the other hand, earthside uses are in an incipient stage of development. In the context of today's international energy crisis, it can be predicted that they will have a brilliant future. (Author)

ENERGY CRISIS SPURS DEVELOPMENT OF PHOTOVOLTAIC POWER SOURCES. A.I. Rosenblatt.

Electronics, v.47, no.7, Apr.4,1974, p.99-111.

As Japan emphasizes solar-energy program, National Science Foundation supervises R&D in the U.S. for terrestrial applications of solar cells; universities join business in seeking economical electric-power systems.

1974

Solar Thermal Electric Power Systems.
 Colorado State Univ., Fort Collins. Solar Energy Applications Lab. Jan 74, 288p NSF-RA/N-74-001 PB-231 115/7WE PC\$6.75/MF\$1.45

The objective of this research program is to develop design parameters for solar thermal electric power systems that can provide lowest cost electric power. Parametric performance and cost models are being developed for subsystems such as the concentrator, flat plate collector, absorber-heat transfer, heat transport, heat storage, heat engine and cooling tower. Cost optimization methods are being developed, which can be used to select cost effective subsystem units, subsystem groups and to optimize the entire system. Power systems of 3 to 100 MW capacity that can be utilized in electrical networks are being considered. Portions of this document are not fully legible.

DIRECT SOLAR ENERGY CONVERSION FOR TERRESTRIAL

USE. K.W. Boer.

J. Environmental Sciences, Jan/Feb.1974, p.8-14.

Large scale use of low priced CdS/Cu₂S solar cells deployed on inexpensive terrestrial surface structures in conjunction with appropriate power processing systems is proposed. Price estimates are given and indicate for typical systems consumer rates comparable to the current rates for electric energy.

SOLAR POWER: PROMISING NEW DEVELOPMENTS.

A.L. Hammond.

Science, v.184, June 28,1974, p.1359-1360.

Plans for near-term applications of photovoltaic solar cells are discussed.

Solar Thermal Conversion Mission Analysis. Volume I:

Summary Report.

Aerospace Corp., El Segundo, Calif. Civil Programs Div. 15

Jan 74, 230p ATR-74(7417-05)-1-Vol-1, NSF-RA/N-74-017

Paper copy available in set of 5 reports as PB-232 667-SET, PC\$18.00.

PB-232 668/4WE PC\$6.00/MF\$1.45

The summary report presents principal interim results of Solar Thermal Conversion Mission Analysis. Results are primarily methodological and are intended to provide an analytical procedure that will consistently evaluate alternative solar thermal conversion concepts in a variety of realistic operating environments. Various sections summarize demand, insolation, margin, mission/system, economic, siting, and environmental methodologies and analyses developed under initial six-month contract. More details are described in four additional volumes. Technical and economic results in this report are preliminary and serve primarily to illustrate the potential capabilities of the methodology itself. (Modified author abstract)

Solar Thermal Conversion Mission Analysis. Volume II:

Demand Analysis.

Aerospace Corp., El Segundo, Calif. Civil Programs Div. 15

Jan 74, 61p ATR-74(7417-05)-1-Vol-2, NSF-RA/N-74-017A

Paper copy also available in set of 5 reports as PB-232 667-SET, PC\$18.00.

PB-232 669/2WE PC\$3.75/MF\$1.45

The objectives of the analysis were to develop a methodology capable of characterizing future electric power demand data and to apply this methodology to forecast Southern California hourly electric power demand for the years 1980-2000. Forecasts of demand data exhibiting cyclic variations consistent with observed behavior patterns are necessary inputs to the solar thermal conversion system simulation. The approach used in meeting these objectives consists of several steps.

Background information, technical reports and raw data were acquired from governmental agencies and utilities throughout the country and particularly Southern California. A demand model was postulated to include factors describing a growth trend, weather conditions, seasonal influences, and hourly cyclic variations. A correlation between demand and weather, or insolation factors was investigated. A methodology was developed to decompose the time series representing the historic Southern California hourly electric power demand, and to recompose a future demand profile incorporating the historic cyclic variations with a projected trend and statistically varied weather influences.

Solar Thermal Conversion Mission Analysis. Volume III:

Southern California Insolation Climatology.

Aerospace Corp., El Segundo, Calif. Civil Programs Div. 15

Jan 74, 119p ATR-74(7417-05)-1-Vol-3, NSF-RA/N-74-017B

Paper copy also available in set of 5 reports as PB-232 667-SET, PC\$18.00.

PB-232 670/0WE PC\$4.50/MF\$1.45

An insolation data base consisting of hourly values of normal incidence (direct) insolation and total insolation for a two-year period has been prepared in computer-compatible format for eight stations characterizing Southern California and for Albuquerque, New Mexico. The data base includes, in addition to the insolation data, solar position information, and weather information. When measured insolation values are unavailable, estimated values, obtained by statistical procedures discussed in this report, are inserted so that the insolation data are complete. Some preliminary statistical studies have been performed on these data, including a comparison of insolation at various stations, a percentile frequency analysis of insolation values and a temperature insolation correlation analysis. In addition a literature survey of the information available about the distribution of sky brightness was made. The procedures used and the results of these various studies are discussed in detail in this report.

Solar Thermal Conversion Mission Analysis. Volume IV:

Mission/System and Economic Analysis.

Aerospace Corp., El Segundo, Calif. Civil Programs Div. 15

Jan 74, 158p ATR-74(7417-05)-1-Vol-4, NSF-RA/N-74-017C

Paper copy also available in set of 5 reports as PB-232 667-SET, PC\$18.00.

PB-232 671/8WE PC\$5.00/MF\$1.45

The report describes the mission/systems and economic analyses performed to examine the dynamic interaction of insolation, demand, and solar power systems. These analyses used the hourly demand projections and regional insolation data described in the previous volumes. A methodology was developed to parametrically assess the performance characteristics of alternative solar thermal conversion missions and systems in realistic operating environments on a consistent basis. When solar thermal conversion solar power plants are integrated with conventional nuclear and fossil power plants in a total power grid, a margin analysis must be performed to ensure that the integrated system provides equally reliable electric service. Having parametrically determined the technical performance of solar power plants for different modes of operation, a comparative economic evaluation of these alternative power plant concepts and conventional power plants can be made.

Solar Thermal Conversion Mission Analysis. Volume V: Area Definition and Siting Analysis.
Aerospace Corp., El Segundo, Calif. Civil Programs Div. 15
Jan 74, 77p ATR-74(17-05)-1-Vol-5, NSF-RA/N-74-017D
Paper copy also available in set of 5 reports as PB-232 667-SET, PCS18.00.
PB-232 672/6WE PCS4.00/MFS1.45

The document presents the results of an area definition and siting analysis: First, to define and characterize Southern California study region and, second, to identify the area within the region judged to be potentially suitable for siting solar power plants. Boundaries were chose to conform to state boundaries on the west, south, and east and with limits of the Southern California Edison Company service territory on the north. This region contains a wide variety of climatological and geological conditions and is served by three major electrical utilities - Southern California Edison Company, Los Angeles Department of Water and Power, and San Diego Gas and Electric Company. Land area was identified as potentially suitable by the sequential application of technical and institutional exclusion criteria then identifying those locations which were not excluded by any of the criteria. Between 5,000 and 15,000 square miles out of a total of 67,000 square miles were found to be potentially suitable for siting large, central-station solar power plants.

TITLE: Continuous Silicon Solar Cells - First Quarter Progress Report (Covering the Period January 1, 1974 to March 31, 1974)
AUTHOR: Chalmers, B.; Surek, T.; Mlavsky, A.I.; Jewett, D.W.; Swartz, J.C.; Wald, P.
CORPORATE AUTHOR: Harvard University, Division of Engineering and Applied Physics; Tyco Laboratories Inc., Corporate Technology Center
ADDRESS: Harvard, Cambridge, MA 02138; Tyco, 16 Hickory Drive, Haltham, MA 02154
PUBLICATION DESCRIPTION: Report No. MSP/RANW/SE/GI-37067X/PR/74/1, 23 p.
PUBLICATION DATE: 1974, April
SPONSOR: National Science Foundation, RANW Program
ABSTRACT: This report summarizes research progress on the application of the EPG crystal growth process to the continuous growth of single crystal silicon ribbons from the melt. Analysis of experimental data in conjunction with a macroscopic model of the growth process leads to the conclusion that a detailed study of the microscopic meniscus-interface junction is required for a complete understanding of the growth stability. Die and furnace designs which improve the stability of the EPG process are described. Results of ribbon growth experiments and of solar cell fabrications are presented. (auth)

TITLE: Research on Cadmium Stannate Selective Optical Films for Solar Energy Applications. Annual Progress Report (Covering the Period July 1, 1973 to December 31, 1973)
AUTHOR: Raacke, G.
CORPORATE AUTHOR: American Cyanamid Co., Chemical Research Division
ADDRESS: Stamford, CT
PUBLICATION DESCRIPTION: Report No. MSP/RANW/SE/GI39539/PR73/4, 25 p.
PUBLICATION DATE: 1974, January
SPONSOR: National Science Foundation, RANW Program
ABSTRACT: The objective of this research is to develop transparent electrically conductive cadmium stannate (Cd₂SnO₄) coatings for use in solar energy conversion devices. A radio-frequency technique was developed for the deposition of the coatings onto transparent substrates. Substantial progress was made toward the goal of optimized electrical and optical film properties by adjusting the deposition parameters. Electrical conductivities near 3500 ohm(-1)cm(-1) were achieved. (NPE)

THE HYDROGEN ECONOMY MIAMI ENERGY (THEME) CONFERENCE.

Presented by The School of Engineering &
Environmental Design, Univ. Miami, Coral
Gables, Florida.

Sponsored by The National Science Foundation,
Defense Advanced Research Projects Agency,
and The School of Continuing Studies, Univ.
of Miami.

Miami Beach, Florida, Mar.18-20,1974.

**THERMOCHEMICAL WATER CRACKING USING
SOLAR HEAT**

C. J. Swet, The Johns Hopkins University, Silver
Spring, Maryland

**PERFORMANCE AND OPTIMIZATION STUDY OF A
SOLAR POWERED HYDROGEN PLANT**

D. V. Merrifield, Sperry Rand Corporation, Hunts-
ville, Alabama

**SOLAR ENERGY AND HYDROGEN PRODUCTION -
AN EXAMINATION OF TWO POSSIBLE SYSTEMS**

D. O. Lee, W. H. McCulloch, Sandia Laboratories,
Albuquerque, New Mexico

**UTILIZATION OF SOLAR ENERGY FOR
HYDROGEN PRODUCTION BY CELL FREE SYSTEM
OF PHOTOSYNTHETIC ORGANISMS**

A. Mitsui, University of Miami, Coral Gables,
Florida

**ONLY SOLAR ENERGY PROCESSES WILL BRING
US TO THE HYDROGEN ECONOMY**

W. Heronemus, University of Massachusetts,
Amherst, Massachusetts

**SEA-SOLAR POWER AS A HYDROGEN GENERA-
TOR**

J. H. Anderson, Sea Solar Power, Inc., York
Pennsylvania

**OCEAN BASED SOLAR-TO-HYDROGEN ENERGY
CONVERSION MACRO SYSTEM**

W. J. D. Escher, Escher Technology Associates, St.
Johns, Michigan; J. A. Hanson, Oceanic Institute,
Waimanalo, Hawaii

**SOLAR-HYDROGEN GENERATION WITH
MULTIPLE FREE PISTON STIRLING ENGINES**

J. Rauch, W. Beale, S. Lewis, Ohio University,
Athens, Ohio

**PHOTOLYSIS OF WATER AS A SOLAR ENERGY
CONVERSION PROCESS: AN ASSESSMENT**

S. Paleocrassas, Tri-State College, Angola, Indiana

**RECENT ADVANCES IN THE CONVERSION OF
SOLAR ENERGY TO ELECTRICITY**

J. O. 'M. Bockris, The Flinders University of South
Australia, Adelaide, Australia

**RELIABILITY OF LOW COST $\text{Cu}_2\text{S/CdS}$ SOLAR
CELLS FOR LARGE SCALE CONVERSION OF
SOLAR TO ELECTRICAL ENERGY**

L. Pertain, M. Sayed, University of Delaware,
Newark, Delaware

(SLA-74-91) SOLAR COMMUNITY: ENERGY FOR RESIDENTIAL HEATING, COOLING, AND ELECTRIC POWER. McCulloch, W. H.; Lee, D. O.; Schimmel, W. P. Jr. (Sandia Labs., Albuquerque, N. Mex. (USA)). Feb 1974. Contract AT(29-1)-789. 18p. (CONF-740213-3). Dep. NTIS \$3.00.

From 140th meeting of The American Association for the Advancement of Science; San Francisco, California, USA (25 Feb 1974).

A series of systems studies on the potential uses of solar energy was conducted at Sandia Laboratories. The outcome of these studies is a new concept, the Solar Total Energy Community. This is a residential community which could significantly reduce its fossil fuel energy consumption by using the sun as the source for most of the community's energy needs. A system computer program, developed for the study, was used to examine several candidate systems and to optimize the operation of the interrelated components which provide space heating, air conditioning, water heating, and electricity for residences and light commercial buildings. An experimental program has been initiated to investigate various technological areas relative to the concept. The study shows that the Solar Community is technologically feasible and that the projected costs warrant the further investigation of solar energy as an alternative residential energy source. This paper reviews the previous work, reports recent findings and improvements, and presents the current status of the continuing analytical and experimental efforts. (auth)

Applied Research on II-VI Compound Materials for Heterojunction Solar Cells.

Richard H. Bube, Alan L. Fahrenbruch, Fredrik Buch, Kim Mitchell, and Valery Vasilchenko. Stanford Univ., Calif. Dept. of Materials Science and Engineering. 15 Apr 74. 25p NSF-RA/N-74-030. NSF-RANN/SE/GI-38445X/PR-74-1 PB-232 884/7WE PC\$3.00/MF\$1.45

Continuing research aimed at developing large-area cells for terrestrial applications the authors have (1) investigated the properties of high resistivity i-layers occurring near the junction interface between the CdS and the CdTe, (2) used thermoelectric power measurements to investigate the electrical transport properties of CdTe films deposited by close-spaced vapor-transport, (3) explored the effect of thermally etching the CdS substrates on the epitaxy of CdTe films, and (4) used H₂ anneals to convert high resistivity evaporated CdS films to low resistivity (< 1 ohm cm) films. During this period film-crystal cells with solar efficiencies of up to 5.2%, open circuit voltages up to 0.66 V in sunlight, and fill factors of 49% have been produced.

(SLA-74-124) SOLAR TOTAL-ENERGY COMMUNITY PROJECT. Brandvold, G. E. (Sandia Labs., Albuquerque, N. Mex. (USA)). Mar 1974. Contract AT(29-1)-789. 9p. Dep. NTIS \$4.00.

The concept of a solar total-energy community entails collecting solar energy at a central area, converting part of it to electricity, and distributing the rest of it to homes and/or businesses for space heating or cooling. The Sandia Laboratories' concept for such uses of solar energy, its departure from other solar-energy approaches, and the development program being conducted to further explore its feasibility are described. (auth)

Reliability of low-cost CdS/CdTe solar cells. SART, S. M. PARTIAL, L. D. at (Mottet-Peckard Co., Palo Alto, Calif.) at (Delaware University, Newark, Del.) 2 May 1974. 2 pages. 10 refs.

Electronics Letters, vol. 10, May 2, 1974, p. 169.

168. NSF-supported research.

*ACCELERATED LIFE TESTS, *COST REDUCTION, *RELIABILITY

*ENGINEERING, *SERVICE LIFE, *SOLAR CELLS, *TEMPERATURE

EFFECTS

CADMIUM SULFIDES, CIRCUIT REPAIRABILITY, COPPER SULFIDES,

ENERGY CONVERSION EFFICIENCY, ENERGY TECHNOLOGY,

EXTRAPOLATION, SHORT CIRCUITS, THERMAL DIFFUSION

C93 174-25923

TITLE: Research Applied to Solar-Thermal Power Systems - Chemical Vapor Deposition Research for Fabrication of Solar Energy Converters. Annual Progress Report (Covering the Period January 1, 1973 to December 31, 1973)

AUTHOR: Seraphin, B.O.

CORPORATE AUTHOR: University of Arizona, Optical Sciences Center

ADDRESS: Tucson, AZ 85721

PUBLICATION DESCRIPTION: Report No. NSP/RANW/SE/GI367311/PR73/3, 81 p.

PUBLICATION DATE: 1974, January 31

SPONSOR: National Science Foundation, RANN Program

ABSTRACT: This project will support research on a new approach to a selective solar energy converter that can be used to transform solar radiation into high temperature heat. This heat can be transferred and applied in a steam turbine-generator unit to produce electricity. The selective solar energy converter is basically a two-layered construction in which the top layer is a semiconductor material, such as silicon, having high absorption for solar radiation and high transparency for blackbody radiation from the heated unit. The bottom layer is a metal film having high reflectance. A second significant feature of this project is the use of chemical vapor deposition (CVD) techniques for applying semiconductor materials for optical structures. The objective of the project is to adapt the CVD process to the fabrication of multilayered semiconductor coatings, to demonstrate the fabrication of semiconductor absorber-type optical coatings, and to measure the physical characteristics and the optical performance of these coatings as a function of temperature up to 500 degrees C. (Auth)

TITLE: Direct Solar Energy Conversion for Large Scale Terrestrial Use. Annual Progress Report (Covering the Period January 1, 1973 to December 31, 1973)

CORPORATE AUTHOR: University of Delaware, Institute of Energy Conversion

ADDRESS: 70 South Chapel Street, Newark, DE 19711

PUBLICATION DESCRIPTION: Report No. NSP/RANW/SE/GI3672/PR73/4, 96 p.

PUBLICATION DATE: 1974, January

SPONSOR: National Science Foundation, RANN Program

ABSTRACT: Progress is reported on all aspects of the work on Cu₂S/CdS solar cells and their application to direct solar energy conversion for large scale terrestrial use. Topics covered are (1) basic studies of Cu₂S/CdS layers (2) cell lifetimes (3) cell properties at elevated temperatures (4) improved production techniques (5) economic analyses of production costs (6) production of cells and demonstration units (7) systems analysis, and (8) environmental considerations. The techniques used and areas studied include scanning electron microscopy, electron diffraction, Auger spectroscopy, morphology, diffusion, CDS formation, dislocations, heat treatment, and current voltage characteristics. (Auth)

TITLE: Research Applied to Solar-Thermal Power Systems, Semi-Annual Progress Report No. 3 (Covering the Period July 1, 1973 to December 31, 1973)

AUTHOR: Sparrow, E.M.; Ransley, J.W.; Vehner, G.K.

CORPORATE AUTHOR: University of Minnesota; Honeywell Systems and Research Center

ADDRESS: Minneapolis, MN

PUBLICATION DESCRIPTION: Report No. NSP/RANW/SE/GI-34871/PR73/4, 211 p.

PUBLICATION DATE: 1974, January

SPONSOR: National Science Foundation, RANN Program

ABSTRACT: This report documents the research and development efforts of the Minnesota/Honeywell team during the period from July 1, 1973 to December 31, 1973. A scaled model of a solar collector module has been designed and fabricated. Life testing of candidate mirror coatings for the solar concentrator have continued. The performance of solar absorber coatings at various elevated temperatures has been investigated. Heat pipe tests were performed to examine the compatibility of stainless steel and copper containing materials, with water as a working fluid. The night-time cooling and subsequent early morning warming of the pipelines and other fluid-carrying components of the transfer loop were analyzed. Computations were performed to determine the effect of daytime variations of insolation on the heat losses and pumping energy. Steady-state operating characteristics of three transfer loop configurations were computed. The application of Auger Electron Spectroscopy to examine the corrosion damage to heat storage containment vessels has continued. (Auth)

TITLE: Development of Low-Cost Thin Film Polycrystalline Silicon Solar Cells for Terrestrial Applications, Annual Progress Report (Covering the Period June 1, 1973 to December 31, 1973)

AUTHOR: Chu, T.L.

CORPORATE AUTHOR: Southern Methodist University; Texas Instruments

PUBLICATION DESCRIPTION: Report No. NSP/RANW/SE/GI38981/PR73/4, 65 p.

PUBLICATION DATE: 1974, January

SPONSOR: National Science Foundation, RANN Program

ABSTRACT: Polycrystalline silicon films have been deposited on steel substrates at 800-1000 degrees C by the pyrolysis of silane; borosilicate was used as a barrier against the diffusion of iron from the substrate into silicon. The microstructure of the silicon film is determined mainly by the substrate temperature and deposition rate. The conductivity type and electrical resistivity of the deposited silicon have been controlled reasonably well by the addition of dopants during deposition. Schottky barriers and p-n junctions have been fabricated from polycrystalline silicon, and their electrical characteristics have been evaluated. Large area Schottky barrier solar cells have been fabricated from single crystal silicon and their efficiencies measured. The grid structure on the solar cell has been treated anisotropically. (Auth)

TITLE: Environmental Aspects of Cadmium Sulfide Usage in Solar Energy Conversion - Part I, Toxicological and Environmental Health Considerations - A Bibliography

AUTHOR: Esser, H.A.; Olson, L.L.; Quist, G.C.

CORPORATE AUTHOR: University of Delaware, Institute of Energy Conversion

ADDRESS: Newark, DE 19711

PUBLICATION DESCRIPTION: Report No. NSP/RANW/SE/GI-34872/PR73/5

PUBLICATION DATE: 1973, June 1

SPONSOR: National Science Foundation, RANN Program

ABSTRACT: Since we have proposed to use cadmium sulfide solar cells in order to solve a very pressing problem of the energy needs of this civilization, we have undertaken extensive studies to ensure that the introduction of this new technology will not create environmental problems detrimental to the health and well being of the society. Cadmium is known to be a toxic substance and it ought to be treated with respect. Therefore, it is necessary to investigate first the possible routes of introduction of cadmium to the environment due to the development of the proposed technology. If cadmium is to be used in solar cells to a great extent the first problem arises in the procurement and manufacturing operations. The possible sources of this are dealt with in appendix I. Once the solar cells are manufactured and placed on the roofs of dwellings it is possible that due to accidental breakage of the cells some may fall into the hands of a child who may accidentally ingest some of the material. This aspect is considered in appendix II. The second possibility after the installation of the cells is the catastrophic combustion of the building. In this case, from the fire it is possible to release some cadmium aerosol to the atmosphere; this also was a part of this study and a preliminary report on the findings are reported in the appendix III. In the main portion of the work we have reported the results of our search of the literature to determine the known toxicology and the epidemiology of cadmium and cadmium salts. This was done to obtain a base line for the control criteria that we should impose on the manufacture of the solar cells and determine the precautions to be taken in the usage and the handling of the material. (Auth, from introduction)

1973

1973

A Rational Method for Evaluating Solar Power Generation Concepts.

George O. G. Lof, and Susumu Karaki.
Colorado State Univ., Fort Collins. Dept. of Civil
Engineering. May 73. 12p NSF-RA/N-73-050
PB-27 822/4WE PC\$3.00/MF\$1.45

Before committing funds and efforts to the construction and testing of experimental equipment for generating electricity from solar heat, any proposed system should be subjected to careful technical and economic analysis. Important elements which must be included in such analysis and the rationale behind them are discussed. It is not immediately evident that a large scale thermal power plant or a small scale plant have requisite and inherent advantages. Rather, what seems obvious is the necessity for separate appraisal of collector, thermal transport, storage, heat engine, subsystems, and a thorough assessment of an integrated assembly providing for least cost per unit of electrical power output for varying conditions of operation. A broadly based analysis of solar thermal electric power systems is needed to establish a basis for more intensive research and development efforts of specific systems. (Author)

N74-13837# California Univ., Livermore. Lawrence Livermore Lab.

SOLAR PONDS EXTENDED

A. F. Clark 27 Jul. 1973 12 p refs
(Contract W-7406-eng-48)
(UCID-16317) Avail: NTIS HC \$3.00

An effort was made to find and develop a system to produce electrical power from solar energy. The largest item of cost in a solar energy system is the collector, and a solar pond can be made very cheaply compared to mirrors or metal collection or multilayered glass systems. The heat can be transported by stored in, and extracted from water very readily and relatively inexpensively. The present concepts feature a shallow pond that is quickly and readily heated and can be emptied at night, cutting down on the thermal losses. The pond would be filled only when the solar radiation is strong enough to heat the water. The rest of the time the water would be stored in a large insulated reservoir, thus providing as much heat energy storage as desired and certainly enough to last more than a day or so. Calculations indicate that a thermodynamic cycle using some fluid other than water could be more efficient in extracting power. A Freon 11 liquid-vapor system could be the appropriate fluid to run the turbine and generate electricity. Waste heat could be disposed of in a water cooling tower. NSA

LARGE-SCALE SOLAR POWER VIA THE PHOTO-VOLTAIC EFFECT.

Loferski, J. J. (Brown Univ., Providence).
Mech. Eng.; 95: No. 12, 28-32(Dec 1973).

As a result of the proposal for the possibility of using the photo-voltaic cell for large-scale generation of electricity from sunlight, three questions are posed. What area must be covered by solar cells to generate a significant portion of U. S. energy needs? If generated on the surface of the Earth, what methods of energy storage will be used? How much will photovoltaic solar energy conversion systems cost? It is concluded that the area needed is not unreasonable, that methods of energy storage are available, and that there is reason for optimism with respect to reducing the cost for large-scale power generation from sunlight. (MCW)

FEASIBILITY STUDY OF A COORDINATED SOLAR-NUCLEAR SYSTEM IN AN INTEGRATED POWER NETWORK.

Malaviya, B. K. (Rensselaer Polytechnic Inst., Troy, NY).
Trans. Amer. Nucl. Soc.; 16: 240-241(Jun 1973).

From 19th annual meeting of the American Nuclear Society; Chicago, Illinois, USA (10 Jun 1973). See CONF-730611-

A viable basis for a solar-nuclear system complex is described. A well-defined variation in power demand is known to occur during the day. The manner of this variation exhibits a strong correlation with the variation of solar radiation intensity - and therefore, of solar energy availability - during a 24-h period. The overall load consists of a 'base' load and a 'peak' demand superimposed on it. For serving the 'base-load' demand of a network, nuclear units possess special economic and other advantages. In an integrated system, if nuclear and solar units are operated in a mutually complementary fashion, the nuclear unit can be confined primarily to base-load demand, minimizing its 'swing-load' function. The incremental load - which occurs largely during periods of intense sunlight - can be met by solar units. Moreover, such a distribution of load makes use of solar energy in 'live' form, obviating problems of storage batteries.

THE SUNSHINE SPREADERS.

New Scientist, May 10, 1973, p.337-339.

Aden and Marjorie Meinel are dedicated publicists of solar energy. They want to see power farms of 5000 square miles in Arizona, producing power for southern California. Tim Johnson discussed their ideas with them.

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Flat Plate Collectors with CdS Solar Cells and First Indications of Feasibility for Their Large Scale Use.
K. W. Boer, N. Freedman, H. Hadley, W. Nelson, and K. Sencuk.

Delaware Univ., Newark. Inst. of Energy Conversion. 1 Jun 73. 23p NSF-RA/N-73-018, NSF-RANN/SE/GI-34872/TR-73-1

PB-227 958/6WE PCS3.00/MF\$1.45

Results of lifetesting of CdS/Cu₂S solar cells indicate that life expectancies in excess of 20 years under terrestrial conditions may be possible if temperatures are limited to below 50C. Such solar cells are incorporated in flat-plate collectors currently deployed on the roof of the Delaware Solar House. These collectors are described together with a means to limit their operating temperature. The cells can be substantially simplified without marked loss of conversion efficiency and may be produced at a rate of 10th to the 7th power sq m/year for less than \$10/sq m. (Author)

TI: Nitro Photovoltaic Energy System Study
AUTHOR: Eldridge, P.R.
CORPORATE AUTHOR: Nitro Corp.
ADDRESS: Westgate Research Park, McLean, VA 22101
PUBLICATION DESCRIPTION: Summary of Talk Presented at National Science Foundation Workshop on Photovoltaic Conversion of Solar Energy for Terrestrial Applications held October 23-25, 1973

PUBLICATION DATE: 1973, October
SPONSOR: National Science Foundation
ABSTRACT: This paper summarizes various options for the development, production, implementation and operation of photovoltaic systems that would produce electricity and hydrogen fuel gas from solar energy. Estimated future costs of producing electricity, using such systems, are compared with that of conventional systems that use fossil and nuclear fuels. (auth)

N74-17795# Nitro Corp., McLean, Va. Systems Development Div.

SOLAR ENERGY SYSTEMS

Frank R. Eldridge Mar. 1973 100 p refs (M73-26) Avail: NTIS HC \$8.00

Alternative solar energy systems that can be used for generating electricity and producing hydrogen fuels are reviewed. Particular attention is given to the possibility of employing photovoltaic cells to collect the solar energy. Different system sizes are explored, ranging from small household systems of a few kilowatts output, to large systems capable of producing, transmitting, storing, and distributing a major portion of the U.S. energy requirements by the year 2000. Author

CN-140, 102

Research Applied to Solar-Thermal Power Systems.

W. B. Bienert, E. R. G. Eckert, J. M. Hammer, R. C. Jordan, and J. W. Ramsey.

Minnesota Univ., Minneapolis. Jan 73. 286p NSF-RA/N-73-065, NSF-RAN/SE/GI-34871/PR-72-4
PB-228 869/4WE PCS17.50/MF\$1.45

The function of a solar-thermal power system is to supply solar-generated heat to the turbines of an electric power plant. The basic system presently being considered under this program is composed of an array of collectors (consisting of a parabolic reflector which concentrates and directs the solar radiation onto a heat pipe absorber tube in which the energy is transferred to a fluid), a transfer loop (a system of pipes which transports the energy to the power plant proper), and operationally an energy storage system to provide energy during no-sunshine hours. Systems being studied represent current state of technology, but should not be construed as final designs. They represent only baselines from which trade-offs and component research can be conducted. (Author)

Research Applied to Solar-Thermal Power Systems.

G. Beitz, W. B. Bienert, E. R. G. Eckert, J. M. Hammer, and R. C. Jordan.

Minnesota Univ., Minneapolis. Jan 73. 55p NSF-RA/N-73-066, NSF-RANN/SE/GI-34871/PR-72-4
PB-231 591/9WE PCS5.75/MF\$1.45

The function of a solar-thermal power system is to supply solar-generated heat to the turbines of an electric power plant. The basic system presently being considered under this program is composed of an array of collectors (consisting of a parabolic reflector which concentrates and directs the solar radiation onto a heat pipe absorber tube in which the energy is transferred to a fluid), a transfer loop (a system of pipes which transports the energy to the power plant proper), and operationally an energy storage system to provide energy during no-sunshine hours. Systems being studied represent current state of technology, but should not be construed as final designs. They represent only baselines from which trade-offs and component research can be conducted.

A COMMERCIAL SOLAR CELL ARRAY DESIGN

E. L. RALPH*

(Received 24 May 1971)

Abstract—Solar cell arrays designed for space use are not suitable for terrestrial electric power generation applications. The environment on Earth is much different and the commercial price range for these applications is much lower than that for space applications. This paper describes solar cell array designs that provide protection from the terrestrial environment and at the same time bring the array price down from about \$100 per watt (space design price) to about \$25 per watt. Optical efficiency of the concentrator design is 76 per cent. The thermal characteristics of the arrays have been measured and electrical performance data is presented.

METHOD FOR ESTIMATING OPTIMUM LOAD RESISTANCE OF A SILICON SOLAR CELL USED IN TERRESTRIAL POWER APPLICATIONS. Rao, A. B. (Electronics Corp. of India Ltd., Hyderabad); Padmanabhan, G. R. Solar Energy; 15; No. 2, 171-177 (Jul 1973).

Solar intensity undergoes significant changes from dawn to dusk. Further, the power output of a silicon solar cell is a function of the load resistance. A load resistance (R_{opt}) giving maximum conversion efficiency at mid-day becomes less efficient at other times of the day under reduced intensity levels. The load resistance must be optimized to derive maximum overall power output for the whole day, taking intensity variations into account. A method for estimating the optimum load resistance (R_{opt}) is presented here. It is also shown that considerable improvement in the output of a terrestrial power system could be achieved at solar intensities $\leq 100 \text{ MW cm}^{-2}$. (auth)

(UCID-16437) SHALLOW SOLAR POND SCHEME. Performance Assessment of a Model System. Wouters, L. F. (California Univ., Livermore (USA)). Lawrence Livermore Lab., 29 Oct 1973. Contract W-7405-eng-48. 82p. Dep. NTIS \$6.25. The division of energy among the various competing processes to the production of electrical power at a "busbar output" for the Shallow Solar Pond scheme. The solar collector utilizes shallow flowing water to transfer thermal energy to a hot water reservoir (at $\sim 95^\circ\text{C}$). Several layers of plastic sheet cover the collection area to suppress heat losses. A Rankine Cycle thermodynamic system converts part of the heat energy to shaft work and thence to electricity. It would utilize a Freon gas turbine, along with evaporator, condenser and pressurizing pump; the rejected heat would be removed by an evaporation pond (at $\sim 25^\circ\text{C}$). The fiducial system used for this analysis is assumed to have an area of 1 km^2 . It would figuratively deliver an output of $8\frac{1}{2} \text{ MW}$; its mean efficiency for the reference input is 2.8%. The reference operating point corresponds to equinoctial noon, 33°N lat. (No attempt was made to include a summer-winter optimization). The various losses and power expenses are summarized. (MCW)

N74-19894 Escher Technology Associates, St. Johns, Mich. A PROBLEM STATEMENT: OCEAN BASED SOLAR-TO-HYDROGEN ENERGY CONVERSION MACRO SYSTEM William J. D. Escher and Joe A. Hanson (Oceanic Inst.) Nov. 1973 25 p refs

Copyright. Avail. Issuing Activity CSCL 10A
An ocean based solar to hydrogen energy conversion facility is proposed that uses hydrogen as an energy carrier to be delivered to the spectrum of the energy using sector, instead of electricity, because of hydrogen's advantages of transportability and storability. The solar to hydrogen conversion process is conducted on the open ocean, and not in the traditional desert location. A number of coproducts that can also be supplied by the proposed ocean complex includes sea foods, salts, fertilizers, magnesium, and aluminum materials.

Author

N74-18610 Sandia Labs., Albuquerque, N.Mex. ECONOMIC COMPARISON OF TWO SOLAR/HYDROGEN CONCEPTS W. H. McCulloch, R. B. Pope, and D. O. Lee Oct. 1973 12 p refs (Contract AT(29-1)-789) (SLA-73-900) Avail: NTIS HC \$3.00

Two concepts for producing hydrogen from solar energy are examined. The utilization of solar energy and the concept of a hydrogen fuel both have drawbacks. Solar energy is intermittent, interrupted by the diurnal cycle of available sunlight and by weather conditions. Most systems designed to use solar energy include an expensive energy storage mechanism to meet demands during periods when there is no incident solar radiation. Hydrogen generation plants would require large amounts of energy input. The concepts described utilize parameters typical of operation in Albuquerque, New Mexico. It is assumed that the collectors are positioned with the axes in a north-south plane, tilted 35° deg from the horizontal toward the south, with spacing between collectors equal to the collector dimensions.

NSA

THOMAS R. SCHNEIDER, National Center for Energy Management and Power, University of Pennsylvania, Philadelphia, Pennsylvania 19104, U.S.A.

Efficiency of photosynthesis as an solar energy converter: *Energy Conversion* 13, 77-84 (1973).

Summary—The efficiency of the conversion of solar energy into chemical energy in the form of plant material through photosynthesis is discussed. A theoretical upper bound of 11 per cent is obtained. Inclusion of losses resulting from other aspects of plant biology reduces the conversion efficiency to 5-6 per cent in practice. Record daily plant growth rates confirm this figure. This is the conversion efficiency of sunlight reaching the plant; efficiencies based on monochromatic light of optimal wavelengths can yield higher efficiencies, but their use with respect to the problem under consideration is inappropriate. Once converted into organic plant material this stored energy can be released as thermal energy or converted to another fuel such as a substitute natural gas.

Key words: Efficiency photosynthesis solar energy productivity
energy crops yield

A74-24901 Photovoltaic power and its applications in space and on earth; International Congress on the Sun in the Service of Man, Paris, France, July 2-6, 1973. Proceedings (L'energie photovoltaic et ses applications dans l'espace et sur terre; Congrès International sur le Soleil au Service de l'Homme, Paris, France, July 2-6, 1973, Compte Rendu). Congress sponsored by UNESCO. Brétigny-sur-Orge, Essonne, France, Centre National d'Etudes Spatiales, 1973. 662 p. In French and English. \$25.15.

Recent advances in silicon and Cu₂S solar cells are reported in papers dealing with improved device fabrication processes, factors participating in degradation mechanisms, design details of spacecraft solar cell arrays, and prospects of economically justified terrestrial applications. Some particular topics include details of integrated solar cell panels, design features of flexible and deployable large arrays, fabrication methods for thin-film solar cell structures, and the performance of protective coating materials.

T.M.

Individual items are announced in this issue.

N74-10896# Committee on Science and Astronautics (U. S. House).

SOLAR ENERGY FOR THE TERRESTRIAL GENERATION OF ELECTRICITY

Washington GPO: 1973. 51 p. Hearing before Comm. on Sci. and Astronaut., 93d Congr., 1st Sess., No. 12, 5 Jun. 1973. Avail: Subcomm. on Energy

The hearings are presented concerning the concept of terrestrial power stations that convert solar energy into electricity. Solar power farms are discussed, and a solar collector system is described. F.O.S.

N74-12680# Auburn Univ., Ala.
SOLAR POWER GENERATION AND DISTRIBUTION c03
In its TERRASTAR: Terrest. Appl. of Solar Technol. and Res. Sep. 1973. 11 p. refs (For availability see N74-12674 03-34) CSCL 20M

The production of electricity from solar energy is discussed. The economics of the proposed generation and distribution systems are analyzed. The use of photovoltaics for converting solar energy to home heating is proposed. The problems of energy distribution are analyzed from the standpoint of equipment costs and complexity. Author

A74-19485 # Prospects of energy conversion and storage derived from space systems technology. P. L. Bargellini (COMSAT Laboratories, Clarksburg, Md.). Istituto Internazionale delle Comunicazioni, Convegno Internazionale delle Comunicazioni, 21st, Genoa, Italy, Oct. 8-13, 1973, Paper, 36 p. 11 refs.

A review of the state of the art in the energy conversion field indicates that the photovoltaic converter is now the most common and efficient type of energy converter. It is anticipated that recent improvements in silicon solar cells will benefit the development of terrestrial solar power plant technology. Solar power plants in space are also considered as a possibility in the future. V.Z.

N74-14768# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

THE NASA-LEWIS TERRESTRIAL PHOTOVOLTAICS PROGRAM

Daniel T. Bernatowicz. 1973. 8 p. refs. Presented at 10th Photovoltaics Specialists Conf., Palo Alto, Calif., 13-15 Nov. 1973; sponsored by IEEE (NASA-TM-X-71491; E-7828) Avail: NTIS HC \$3.00 CSCL 10A

Research and technology efforts on solar cells and arrays having relevance to terrestrial uses are outlined. These include raising cell efficiency, developing the FEP-covered module concept, and exploring low cost cell concepts. Solar cell-battery power systems for remote weather stations have been built to demonstrate the capabilities of solar cells for terrestrial applications. Author

N74-14498# National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Ala.

SOLAR ENERGY POWER SYSTEM Patent Application
Billy K. Davis, inventor (to NASA) Filed 4 Dec. 1973. 18 p. (NASA-Case-MFS-21628-1; US-Patent-Appl-SN-421702) Avail: NTIS HC \$3.00 CSCL 20M

A solar energy vapor (freon) powered system is described for generating electrical energy in which a portion of the heat absorbed from the sun in daylight is stored for use during darkness by a thermal capacitor. A mass of Pyrene, having a high thermal capacity, liquifies when heat is applied to it and goes through a solidification process to provide a heat output. A highly efficient solar boiler is constructed utilizing an anodized titanium surface and a particular combination of shaped boiler tubes and complementary reflectors. The overall efficiency of the system is further improved by an arrangement of heat recovery devices. NASA

TITLE: Research on Low-Cost Silicon Solar Cell Structure for Large Electrical Power Systems, Semi-Annual Progress Report (Covering the Period January 1 to June 30, 1973)

AUTHOR: Pang, P.H.
CORPORATE AUTHOR: Boston College, Dept. of Physics
ADDRESS: Chestnut Hill, MA 02167
PUBLICATION DESCRIPTION: Report No.

NSP/RANN/SE/GI-30975/73/2, 18 p.
PUBLICATION DATE: 1973, September 15

SPONSOR: National Science Foundation, RANN Program
ABSTRACT: A wide variety of steel substrates, as well as molybdenum and tungsten substrates, have been investigated for the deposition of Si films. We conclude that Si film with a nominal thickness of 10 microns can be grown on all these metal substrates. 2. Si films with preferential orientation with respect to the substrate plane have been successfully grown by the evaporation method. The important benefit of such growth in the Cds solar cell has long been recognized. We have now reached the same landmark in the development of Si film solar cells. 3. During this reporting period, we have also investigated the chemical vapor deposition method. Films are produced by this method with good uniformity and adherence to steel and other substrates that are used in the evaporation method. (Auth)
AVAILABILITY: NTIS, PB 228 879 (\$3.00 paper copy/\$1.45 microfiche)

TITLE: An Improved Schottky Photovoltaic Diode for Solar Energy Conversion, Progress Report (Covering the Period, January 1, 1973 - March 31, 1973)

AUTHOR: Anderson, W.A.; Delahoy, A.E.
CORPORATE AUTHOR: Rutgers University, College of Engineering, Bureau of Engineering Research
ADDRESS: New Brunswick, NJ 08903
PUBLICATION DESCRIPTION: Report No.

NSP/RANN/SE/GI-32726/PR73/1, 9 p.
PUBLICATION DATE: 1973, April

SPONSOR: National Science Foundation, RANN Program
ABSTRACT: Statement of Progress and Accomplishments, January 1, 1973 - March 31, 1973. 1) Two transition metals besides Cr, namely Mo and Nb, have produced good photovoltaic response when used as the thin Schottky barrier metal. 2) Quantitative antireflection results were obtained using SiO evaporated on Schottky photovoltaic diodes. Improved photovoltaic outputs of 33% - 92% were obtained compared to theoretical computer predictions of 95%. 3) A computer solution of the optical problem averaged over the solar spectrum predicts a 77% improved performance using SiO and an 87% improvement using TiO2 antireflection coatings on a 100 angstrom Cr Schottky diode. 4) A thin-film Si device (sputter Al on Pyrex-sputter Si on Al-heat to 620 degrees C-sputter Cr) showed promising results in that good adhesion and coloring were observed. It is significant that the Si adhered to the Al during heating and that the Si formed its own antireflection coating as previously predicted by computer. (Auth)

TITLE: Cds Solar Cell Development
AUTHOR: Kraser, J.J.; Mietubicz, R.A.
CORPORATE AUTHOR: University of Delaware, Institute of Energy Conversion

ADDRESS: Newark, DE 19711

PUBLICATION DESCRIPTION: Report No.

NSP/RANN/SE/GI30872/TR73/12, 31 p.
PUBLICATION DATE: 1973, June 10

SPONSOR: National Science Foundation, RANN Program
ABSTRACT: More than half of the initial part of this program had been concerned with the overall processing aspects of the solar cell. Equipment was designed and constructed to carry out all steps necessary to the manufacturing of thin film cadmium sulfide solar cells. This effort provided the first such cells produced at the Institute of Energy Conversion while also providing valuable guidance in setting up a successful pilot line facility with minimum delay. More recently, this research group has redirected its efforts toward a more detailed and systematic study of the various processing steps involved in the manufacture of these cells. This work has included X-ray, scanning electron microscope and metallographic studies. In addition, it has included an investigation of the temperature of the growing Cds - vapor interface. Investigations were also initiated toward understanding the heat treatment which a cell must undergo after it has been dipped in the CuCl barrier solution. It is this heat treatment that essentially "activates" the cell. Our study also lead to subsequent experiments in the development of a backwall cell, as well as the observation of copper nodules on the dipped cells. Most of this work is necessarily preliminary in nature, but has served to verify some of the observations that have been reported elsewhere. (Auth, Summary modified)

TITLE: An Analytical Study of Misfit Dislocations in Cds Solar Cells

AUTHOR: Chou, T.B.

CORPORATE AUTHOR: University of Delaware, Institute of Energy Conversion

ADDRESS: Newark, DE 19711

PUBLICATION DESCRIPTION: Report No.

NSP/RANN/SE/GI-30872/TR73/3, 8 p., 11 references
PUBLICATION DATE: 1973, June 2

SPONSOR: National Science Foundation, RANN Program
ABSTRACT: The purpose of this study is to examine the behavior of dislocations in Cds solar cells. Special emphasis is placed on the code of interface dislocations in affecting the mechanical behaviors of bimaterial systems. The study is analytical in nature. Comparisons of the theoretical predictions with experimental observations will be made. Close interaction with experimental groups will identify significant problems in the future. (Auth, Free Introduction)

TITLE: Accelerated Life Test of Cds/CuxS Solar Cells

AUTHOR: Partain, L.; Seyed, M.

CORPORATE AUTHOR: University of Delaware, Institute of Energy Conversion

ADDRESS: Newark, DE 19711

PUBLICATION DESCRIPTION: Report No.

NSP/RANN/SE/GI30872/TR73/8
PUBLICATION DATE: 1973, June 1

SPONSOR: National Science Foundation, RANN Program
ABSTRACT: Accelerated lifetime testing has been performed to estimate the length of time Cds/CuxS solar cells can efficiently convert solar to electrical energy without significant degradation. A simulator has been used that has the capability of uniform test cell illumination approximating the solar spectrum and intensity. Cell temperature and ambient gas controls were provided with both a continuous light and a cyclical light and dark illumination mode. The test results indicate that operation of cells in a nitrogen gas environment at 50 degrees C or below should give useful cell lifetimes in excess of 20 years. If the temperature is held to 25 degrees C and below, estimated lifetime exceeds 60 years. When degraded cells have been placed in a dark environment at lower temperatures (approximately 21 degrees C), recovery of over 90 percent of previous power and current has been recorded for specific cells. (Auth, Introduction)

TITLE: Grid Simplification on Cds/CuxS Solar Cells

AUTHOR: Hadley, H.C.

CORPORATE AUTHOR: University of Delaware, Institute of Energy Conversion

ADDRESS: Newark, DE 19711

PUBLICATION DESCRIPTION: Report No.

NSP/RANN/SP/GI30872/TR73/11, 10 references
PUBLICATION DATE: 1973, June

SPONSOR: National Science Foundation, RANN Program
ABSTRACT: The current collecting electrode for the thin film CuxS-Cds solar cells being studied under this research grant is a metal mesh (grid) applied to the CuxS surface. The grid wires must be spaced closely enough to collect the generated current efficiently and spaced widely enough for sufficient transmission of light to the cell. Calculations were performed to determine the optimum spacing and geometry for the grid wires, and the calculations were checked by experiment. (NPG)

TITLE: Research Applied to Solar-Thermal Power

Systems, Semi-Annual Progress Report
(Covering the Period January 1, 1973 to June 30, 1973)

AUTHOR: Seraphin, B.O.
CORPORATE AUTHOR: University of Arizona, Optical Sciences Center

ADDRESS: Tucson, AZ 85721
PUBLICATION DESCRIPTION: Report No. NSP/RANW/SE/GI-36731X/PR/73/1, 55 P.

SPONSOR: National Science Foundation, RANW Program
ABSTRACT: Research during the period covered by this report centered on the interface between the silver reflector and the silicon absorber. Previous studies had established that the thin silver film agglomerated at the temperature of the silicon chemical vapor deposition. In order to eliminate this basic problem in the fabrication of the converter stack, an agglomeration inhibitor was developed. Silver films thus stabilized without deterioration of up to 800 degrees C reflectance. Further refinement of the CVD process resulted in the deposition of 2 micro-m thick silicon films of satisfactory optical quality onto the metallized substrate. For this part of the stack, the measured reflectance spectrum agrees well with the performance calculated under the assumption of IR-transparent silicon and undegraded silver reflectance. Preliminary results of annealing studies show that no degradation of the optical performance of the absorber-reflector stack occurred after 150 hr. anneal at 500 degrees C. The results available at the end of this period can be interpreted as proof for the basic feasibility of the approach using the silicon-on-silver converter. The agreement between measured and calculated optical properties indicates that the predicted performance of the entire converter stack can be obtained once the silicon absorber carries the antireflection layer. (Auth, Summary)

TITLE: Research Applied to Solar-Thermal Power

Conversion, Volume I, Executive Summary.
Final Report Covering the Period June 1, 1971 to January 31, 1973

AUTHOR: Meinel, A.B.; Seraphin, B.O.; McKenney, D.B.; Beauchamp, W.T.; Wells, V.A.; Turner, A.P.; Lopez-Lopez, P.J.
CORPORATE AUTHOR: University of Arizona, Optical Sciences Center

ADDRESS: Tucson, AZ 85721
PUBLICATION DESCRIPTION: Report No. NSP/RANW/SE/GI-30022/PR/73/1, 14 P.

SPONSOR: National Science Foundation, RANW Program
ABSTRACT: This report summarizes studies of solar absorbing coatings of high selectivity, (a/e), and their influence on system design, operation, and economics. Two basically different approaches to high (a/e) coatings were followed: (1) interference thin film coatings and (2) intrinsic absorber coatings using chemically vapor-deposited (CVD) silicon as the absorbing component. (Auth, Project Description)

TITLE: Research Applied to Solar-Thermal Power

Conversion, Volume II, Final Report Covering the Period June 1, 1971 to January 31, 1973

AUTHOR: Meinel, A.B.; Seraphin, B.O.; McKenney, D.B.; Beauchamp, W.T.; Wells, V.A.; Turner, A.P.; Lopez-Lopez, P.J.
CORPORATE AUTHOR: University of Arizona, Optical Sciences Center

ADDRESS: Tucson, AZ 85721
PUBLICATION DESCRIPTION: Report No. NSP/RANW/SE/GI-30022/PR/73/1, 206 P.

SPONSOR: National Science Foundation, RANW Program
ABSTRACT: An NSP (RANW) grant of \$173,000 was used for laboratory fabrication and measurement of solar absorbing coatings of high selectivity, (a/e), and their evaluation for use in electrical power production by means of thermodynamic cycles. Two types of selective coatings were evaluated: one using interference thin film stacks and the second using intrinsic optical absorption of CVD silicon. Interference stacks made of aluminum oxide with molybdenum, gold, and silver for the metal layers yielded an (a/e) up to 30 at 300 degrees C, an improvement in the state of the art by a factor of 3. The CVD stacks were made from silicon over a reflective layer of silver and yielded emittances at 500 degrees C consistent with an (a/e) of over 20 for a complete stack. A variety of problems associated with high-temperature deposition and applications were encountered and solutions were either found or identified. System analysis indicates that (a/e) = 30 is sufficient to permit the use of weather-insensitive planar collectors. A configuration was evaluated in which heat transfer losses for a 1000 MWe system are small. Cost estimates for collector subsystem designs range from \$200/kWe to \$1120/kWe for a 5-year and 35-year lifetime systems, respectively. (Auth)

TITLE: Research Applied to Solar-Thermal Power

Systems, Semi-Annual Progress Report No. 2
Covering the Period January 1 to June 30, 1973

AUTHOR: Eckert, E.R.G.
CORPORATE AUTHOR: University of Minnesota; Honeywell Systems and Research Center

ADDRESS: Minneapolis, MN
PUBLICATION DESCRIPTION: Report No. NSP/RANW/SE/GI-34871/PR/73/2, 217 P.

SPONSOR: National Science Foundation, RANW Program
ABSTRACT: Research activities performed by the Minnesota/Honeywell team during the period from January 1, 1973 to June 30, 1973 are reported. The studies encompassed the solar concentrator, the solar absorber coating, the heat pipe, the transfer loop, and heat storage containment vessels. With respect to the concentrator, analysis has provided definitive information on tracking, shadowing of adjacent collectors, concentration ratio, and concentrator dimensions. Tests were made of the life characteristics of the concentrator reflective coatings and of the absorber surface coating. Operating characteristics of candidate heat pipes have been determined both by analysis and experiments. System studies provided information on heat loss and pressure drop for steady operation of the transfer loop and for the transient behavior initiated by the absence of insulation. The corrosion of containment walls in the presence of phase-change heat storage materials was studied by depth profiling with Auger electron spectroscopy. (Auth)

AVAILABILITY: Prof. E.C. Jordan, Dept. of Mechanical Engineering, University of Minnesota, Minneapolis, MN 55455

TITLE: Solar Thermal Electric Power Systems,

Progress Report for the Period May 1, 1973 to June 30, 1973

CORPORATE AUTHOR: Colorado State University, Solar Energy Applications Laboratory, Electric Corp., Geosearch Laboratory

ADDRESS: CSU, Fort Collins, CO; WZC, Boulder, CO
PUBLICATION DESCRIPTION: 120 p. report
PUBLICATION DATE: 1973, July

SPONSOR: National Science Foundation, RANW Program
ABSTRACT: Colorado State University, in association with the Westinghouse Electric Corporation, have undertaken a program of research in the generation of electric power from solar energy. The objective of the research is a rigorous appraisal of methods for converting solar energy to electricity and a determination of promising methods(s) for future development. There are many possible approaches for generating electrical power from solar energy: the CSU-Westinghouse team will concentrate on thermal-electrical systems. A summary of the first two months of this 18-month program is presented in this report. During this period, organization and other technical meetings were held to establish common framework and base for the CSU-Westinghouse team. This progress report is presented in two parts: (1) the CSU effort and (2) the Westinghouse effort. Scheduled progress for the total of the grant period is indicated in the respective segments of the report. (Auth, Preface)

TITLE: Research on Low-Cost Silicon Solar Cell

Structure for Large Electrical Power Systems, Annual Report, January, 1973

AUTHOR: Pang, P.H.
CORPORATE AUTHOR: Boston College, Dept. of Physics

ADDRESS: Chestnut Hill, MA 02167
PUBLICATION DESCRIPTION: Report No. NSP/RANW/SE/GI-34973/PR/72/4, 43 P., 36 ref.

SPONSOR: National Science Foundation, RANW Program
ABSTRACT: This First Annual Report is divided into five parts: I. The problem of the present energy need and the unique role of electric energy. II. Solar energy - silicon solar cells. III. An idea of basic modification from the conventional configuration: Instead of single crystal monocrystals, a semiconductor film of about 10 micron thick, grown on a low-cost metallic substrate, such as low expansion steel. IV. The method to grow this film and successful result, especially in the crystallographical structure. V. Future area of investigation, especially in the growth of silicon on different steel substrates, the impurity doping to the silicon film and electrical connections. (Auth, Summary)

TITLE: Research Applied to Solar-Thermal Power

Conversion, Volume I, Executive Summary.
Final Report Covering the Period June 1, 1971 to January 31, 1973

AUTHOR: Meinel, A.B.; Seraphin, B.O.; McKenney, D.B.; Beauchamp, W.T.; Wells, V.A.; Turner, A.P.; Lopez-Lopez, P.J.
CORPORATE AUTHOR: University of Arizona, Optical Sciences Center

ADDRESS: Tucson, AZ 85721
PUBLICATION DESCRIPTION: Report No. NSP/RANW/SE/GI-30022/PR/73/1, 14 P.

SPONSOR: National Science Foundation, RANW Program
ABSTRACT: This report summarizes studies of solar absorbing coatings of high selectivity, (a/e), and their influence on system design, operation, and economics. Two basically different approaches to high (a/e) coatings were followed: (1) interference thin film coatings and (2) intrinsic absorber coatings using chemically vapor-deposited (CVD) silicon as the absorbing component. (Auth, Project Description)

TITLE: Research Applied to Solar-Thermal Power

Conversion, Volume II, Final Report Covering the Period June 1, 1971 to January 31, 1973

AUTHOR: Meinel, A.B.; Seraphin, B.O.; McKenney, D.B.; Beauchamp, W.T.; Wells, V.A.; Turner, A.P.; Lopez-Lopez, P.J.
CORPORATE AUTHOR: University of Arizona, Optical Sciences Center

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TITLE: Research Applied to Solar-Thermal Power

Systems, Semi-Annual Progress Report No. 2
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AUTHOR: Eckert, E.R.G.
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ABSTRACT: Research activities performed by the Minnesota/Honeywell team during the period from January 1, 1973 to June 30, 1973 are reported. The studies encompassed the solar concentrator, the solar absorber coating, the heat pipe, the transfer loop, and heat storage containment vessels. With respect to the concentrator, analysis has provided definitive information on tracking, shadowing of adjacent collectors, concentration ratio, and concentrator dimensions. Tests were made of the life characteristics of the concentrator reflective coatings and of the absorber surface coating. Operating characteristics of candidate heat pipes have been determined both by analysis and experiments. System studies provided information on heat loss and pressure drop for steady operation of the transfer loop and for the transient behavior initiated by the absence of insulation. The corrosion of containment walls in the presence of phase-change heat storage materials was studied by depth profiling with Auger electron spectroscopy. (Auth)

AVAILABILITY: Prof. E.C. Jordan, Dept. of Mechanical Engineering, University of Minnesota, Minneapolis, MN 55455

TITLE: Solar Thermal Electric Power Systems,

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TITLE: Research Applied to Solar-Thermal Power

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CORPORATE AUTHOR: University of Arizona, Optical Sciences Center

ADDRESS: Tucson, AZ 85721
PUBLICATION DESCRIPTION: Report No. NSP/RANW/SE/GI-30022/PR/73/1, 14 P.

(SLA-73-1026) TRANSCRIPT OF TALK ON SOLAR ENERGY. Stromberg, R. P. (Sandia Labs., Albuquerque, N. Mex. (USA)). Dec 1973. Contract AT(29-1)-789. 16p. Dep. NTIS \$3.00.

The report presents a transcript of a solar energy talk that emphasizes the potential for a solar community as developed by Sandia Laboratories, Albuquerque, New Mexico. (auth)

Study terrestrial applications of solar cell powered systems Final Report Seliotek, Sybar, Calif.

RAVIN, J. W. SEP. 1973 136 PAGES

NASA-CR-134512 AVAIL. NTIS MC 89.75

*ELECTRIC POWER SUPPLIES, *SOLAR CELLS, *SOLAR ENERGY CONVERSION, *UTILIZATION
ROCKET SPECIFICATIONS, MARKETING, PRODUCT DEVELOPMENT,
SOLAR GENERATORS
C03 878-21685#

(SLA-73-357) SOLAR COMMUNITY AND THE CASCADED ENERGY CONCEPT APPLIED TO A SINGLE HOUSE AND A SMALL SUBDIVISION. A Status Report. Pope, R. B.; Schimmel, W. P. Jr. (Sandia Labs., Albuquerque, N. Mex.). May 1973. 35p. Dep. NTIS \$3.00.

An analytical study of the application of the Sandia Laboratories solar community concept to a single house and to a 20-house subdivision is described. The specific system analyzed utilizes focused collectors, high-temperature water storage, and cascaded energy. Daily and annual projected performances of different collector fields and the annual projected fuel savings and relative costs of the system are presented for a community located in Albuquerque, New Mexico. Requirements for the peak heating and air conditioning demands are shown. (auth)

(SLA-73-5411) SOLAR COMMUNITY. Stromberg, R. P. (Sandia Labs., Albuquerque, N. Mex.). [nd]. 8p. (CONF-730517-1). Dep. NTIS \$3.00.

From energy crisis symposium; Albuquerque, New Mexico, USA (3 May 1973).

The problems of concentrating the energy from the Sun and the expense of that energy, and maximum use of that energy in a New Mexico community are examined. Heating a fluid with solar collectors and using the energy in the fluid for uses as it cools is explained in the "Solar Community". (JCW)

(SLA-73-5318) COMBINATION OF SOLAR ENERGY AND THE TOTAL ENERGY CONCEPT: THE SOLAR COMMUNITY. Pope, R. B.; Schimmel, W. P. Jr.; Lee, D. O.; McCulloch, W. H.; Bader, B. E. (Sandia Labs., Albuquerque, N. Mex.). [nd]. 8p. (CONF-730811-5). Dep. NTIS \$3.00.

The feasibility of using solar energy to provide most of the residential energy needs in a coherently designed Solar Community is investigated analytically. This innovative concept of a Solar Community is based upon the premise that solar energy can be collected, stored, and then used to provide electricity (through Rankine cycle turbines and electric generators) and comfort conditioning. As designed, solar energy is backed up with supplementary fossil fuel for the periods when stored solar energy is depleted. Five different Solar Community concepts are analyzed and evaluated in terms of projected fuel savings and annual total energy costs. The system that appears most promising is a cascaded system using focused collectors, storage, and a derated turbine where the exhaust energy is "cascaded" into sensible heat storage for use in comfort conditioning. Depending upon the system chosen, annual fuel savings of 45 to 65% could be obtained. Economic parity with existing systems could occur in the 1980's or early 1990's, based upon a moderately increasing utility rate schedule. If utility costs become prohibitive, the proposed system could become competitive much sooner. (auth)

(SLA-73-1056) PROPOSAL TO NSF FOR SUPPORT OF SYSTEMS ANALYSIS COMPUTER PROGRAM PROPOSED FOR SOLAR COMMUNITY TOTAL ENERGY CONCEPT. Stromberg, R. P.; Edsall, M. W.; Thomsberg, S. (Sandia Labs., Albuquerque, N. Mex. (USA)). Dec 1973. Contract AT(29-1)-789. 28p. Dep. NTIS \$3.50.

Sandia Laboratories is proposing that the NSF sponsor a program for the development of a new, more sophisticated systems analysis of solar energy systems. The analysis will be primarily aimed at the solar total energy concept, but it should also be applicable to other solar thermal applications. The effort will require the development of a flexible computer program that will control and manipulate individual component subroutines to determine their impact on the total system. The program will determine solar system costs and fossil fuel savings as compared to those associated with conventional fossil fuel system. (auth)

74N22704** ISSUE 14 PAGE 1632 CATEGORY 3 NASA-CR-138209
 NSF-RA-N-74-013-VOL-1 JPL-SP43-3-VOL-1 NAS7-100 NSF A5-485 73/00/00
 117 PAGES UNCLASSIFIED DOCUMENT
 WORKSHOP PROCEEDINGS: PHOTOVOLTAIC CONVERSION OF SOLAR ENERGY FOR
 TERRESTRIAL APPLICATIONS. VOLUME 1: WORKING GROUP AND PANEL REPORTS
 JET PROPULSION LAB., CALIF. INST. OF TECH., PASADENA. AVAIL.NTIS
 HC \$9.00

PROC. HELD AT CHERRY HILL, N. J., 23-25 OCT. 1973
 /♦ENERGY SOURCES/♦PHOTOVOLTAIC CELLS/♦SILICON/♦SOLAR ENERGY
 CONVERSION/ COST EFFECTIVENESS/ ENERGY TECHNOLOGY/ PRODUCTION
 ENGINEERING/ SEMICONDUCTOR DEVICES/ SOLAR CELLS

74N22705** ISSUE 14 PAGE 1632 CATEGORY 3 NASA-CR-138193
 NSF-RA-N-74-013-VOL-2 JPL-SP43-3-VOL-2 NSF A5-485 73/00/00 294
 PAGES UNCLASSIFIED DOCUMENT
 WORKSHOP PROCEEDINGS: PHOTOVOLTAIC CONVERSION OF SOLAR ENERGY FOR
 TERRESTRIAL APPLICATIONS. VOLUME 2: INVITED PAPERS
 JET PROPULSION LAB., CALIF. INST. OF TECH., PASADENA. AVAIL.NTIS
 HC \$17.75

SPONSORED BY NASA PROC. HELD AT CHERRY HILL, N. J., 23-25 OCT.
 1973

/♦PHOTOVOLTAIC CELLS/♦SILICON/♦SINGLE CRYSTALS/♦SOLAR ENERGY
 CONVERSION/ CADMIUM SULFIDES/ COST EFFECTIVENESS/ ENERGY SOURCES/
 POLYCRYSTALS/ SEMICONDUCTOR DEVICES/ THIN FILMS

(UCID-16386(Pt. 1)) ECONOMICS OF THERMODY-
 NOMIC SOLAR POWER SYSTEMS. I. The Efficiency Function.
 Wouters, L. F. (California Univ., Livermore (USA). Lawrence
 Livermore Lab.). 4 Sep 1973. Contract W-7405-eng-48. 12p.
 Dep. NTIS \$3.00.

Thermodynamic schemes are being studied for central power
 systems having early applicational viability. The TD schemes
 universally involve an extensive thermal subsystem (that col-
 lects the solar flux and delivers its energy as heat) coupled to a
 central thermodynamic subsystem (that converts the heat to
 work). Various degrees and models of storage may be invoked
 to supply power beyond the mere solar day, in time. The com-
 pleté economic situation is examined in view of the present in-
 flationary condition. The various solar collector field concepts
 exhibit capital costs running between \$900 to \$2500 per kw. The
 central plant equipment includes heat exchangers, turbo-genera-
 tors, pumps, and other TD machinery, at \$50 to \$150 per kw;
 storage schemes reflect \$50 to \$200 per kw. (NCW)

(UCID-16386(Pt. 2)) ECONOMICS OF THERMODY-
 NOMIC SOLAR POWER SYSTEMS. II. The Turbine Trade-Off.
 Wouters, L. F. (California Univ., Livermore (USA). Lawrence
 Livermore Lab.). 19 Sep 1973. Contract W-7405-eng-48. 7p.
 Dep. NTIS \$3.00.

It has been indicated that a more expensive, higher efficiency
 thermodynamic subsystem could result in a less-expensive, more
 "cost-effective" solar power system, overall. It is interesting to
 see how severe a trade-off this really is. A primitive two-com-
 ponent system model consisting of (1) the collector and (2) the
 turbine was constructed. Of course there are lots of other pieces
 between and around these items, but these two are the ones to
 which most "cost leverages" can be associated, in some way.
 A given collector design is assumed, having a defined specific
 efficiency and unit area cost. The turbine efficiency is varied
 parametrically from a reference value, and an allowable cost
 trade-off as a ratio to reference turbine price is obtained. No
 attempt is made to relate a particular cost change to a particular
 design change. The maximum that can be afforded for any and all
 changes is established. (auth)

1973

1973

LARGE SCALE SOLAR ELECTRIC POWER GENERATION

E. L. RALPH*

(Received 15 May 1971)

Abstract—The need for a new source of energy for generating electric power has been well established. This new energy source must be able to meet the many demands of our society in respect to resource depletion, increased electrical power requirements, peak demands, site location, low costs, and the elimination of pollution. The one energy source that provides a solution to these problems is solar energy. Although no significant effort or funds are being spent on solar energy research, there are indications that this energy could be tapped with present day technology. This paper describes some features of a large scale solar cell electric power generating system that could be built to show the feasibility of utilizing solar energy. The basic system components are described and an engineering analysis made of the electrical, optical, mechanical, and thermal characteristics of the system.

1972

THE SOLAR ERA: PART 2 - POWER PRODUCTION WITH SMALL SOLAR ENGINES.. Farrington Daniels. Mechanical Engineering, Sept. 1972, p.16-19.

Theoretically, sunlight can supply all the electric power we need. Over 100 million acres of unoccupied public lands in five of our southwestern states are bathed in solar radiation sufficient to produce (using conservative conversion factors) 6.7×10^{13} kwh annually. This is 40 times the present total annual production. Small solar engines and generators can now be built for about \$1000/kw compared with \$200/kw in large conventional installations—an appreciable difference. But the cost is low enough and the rewards of success great enough to justify further research and exploration.

559

TITLE: The Impact of Solar Heating on Electric Utility Generation
AUTHOR: Zisenberg, L.; Chul Yoon, S.
CORPORATE AUTHOR: University of Pennsylvania, National Center for Energy Management and Power; University of Pennsylvania, Youne School of Civil and Mechanical Engineering
ADDRESS: Philadelphia, PA. 19106
PUBLICATION DESCRIPTION: Report No. MSP/RAN/SE/G127976/TR72/17, 19 p.
PUBLICATION DATE: 1972, November
SPONSOR: National Science Foundation, RANW Program
ABSTRACT: The extent of savings in electrical generation costs resulting from the use of solar heating to reduce the winter weather sensitive load was investigated. The results are given in terms of generation costs saved vs. the percentage of the load supplied by the solar heating system. This information would be useful to utilities that traditionally peak in the winter or those that have similar summer and winter peaking characteristics. Additional work should be performed to determine the correlation between severe weather conditions and the presence (or lack) of solar heating from an availability of generation equipment point of view. (auth)

1972

A72-36075 Large-scale concentration and conversion of solar energy. A. F. Hildebrandt, G. M. Haas, W. R. Jenkins (Houston, University, Houston, Tex.), and J. P. Colaco. EOS, vol. 53, July 1972, p. 684-692, 31 refs.

Description of a proposed solar energy power plant which first concentrates the solar energy and then applies a thermodynamic conversion cycle. A concentrator is proposed which consists of a large number of individual movable mirrors which reflect the solar energy onto a single collector atop a large tower. The concentrated energy can then be converted to electrical power either by means of a steam cycle, using liquid metals for heat transfer down the tower, or by a closed-cycle MHD generator; in this case preference is given to a closed-cycle MHD process employing an inert gas of helium with cesium seeding. The intermittent nature of the solar energy can be overcome by electrolyzing water into hydrogen and oxygen gas and storing the energy either in the form of compressed hydrogen and oxygen gas or as cryogenic liquids. Energy storage in the form of hydrogen is especially attractive, since it offers the possibility of a pollution-free fuel for the internal combustion engine. A.B.K.

PHOTOVOLTAIC CELLS: DIRECT CONVERSION OF SOLAR ENERGY. A.L. HAMMOND. Science, v.178, Nov.17,1972, p.732,733.

SOLAR-ELECTRIC RESIDENTIAL POWER SYS-
TEM. Bachus, C. E. (Arizona State Univ., Tempe). pp 704-
711 of 7th Intersociety Energy Conversion Engineering Con-
ference. Washington: American Chemical Society (1972).

From 7th Intersociety energy conversion engineering conference;
San Diego, California, USA (25 Sep 1972). See CONF-720925-.

The technical feasibility of using a solar cell covered roof on a
private residence to provide all of the energy requirements of the
home was investigated. The energy storage was by electrolysis of
water coupled with a fuel cell. The daily and monthly variations in
solar energy in the Phoenix area and the projected energy demands
of a home were taken into account. The reference design of the
system uses present-day technology and the parameters assumed
are conservative. A parametric analysis of the system indicated
the sensitive components and the potential of future systems. The
reference design system would have no trouble in supplying the
energy demands of the home except for a few days in December.

An energy storage capacity of more than four days would be re-
quired for that period. This system could also produce about 700 lb
of excess hydrogen per year that could be used as an energy source
for other systems. Although this solar-electric system is tech-
nically very feasible, its attractiveness will require a large reduc-
tion in the cost of solar cells. (auth)

A PROPOSED NEW CONCEPT FOR A SOLAR ENERGY CONVERTER.

R.L. Bailey, Univ. Florida.

Jour. Engineering for Power, v.94, Ser.A, no.2,
Apr.1972, p.73-77.

The concept is called an Electromagnetic Wave Energy
Converter (EWEC). The concept is a pyramidal
solar radiation absorber-converter structure. It is
based on the possibility of extending concepts of
power absorbing antennas and converters to the
visible light range.

N73-12061# Los Alamos Scientific Lab., N.Mex.

LASER ACTIVATION OF SOLAR CELLS

Charles E. Backus 1972 11 p refs Presented at 9th IEEE
Photovoltaic Specialist Conf., Silver Spring, Md., May 1972
Sponsored by AEC

(LA-DC-72-468; Conf-720518-1) Avail: NTIS

A preliminary investigation was conducted on the feasibility
of using photovoltaic cells to convert laser energy into electrical
energy. The tests were made with readily available solar cells
and lasers. When using the He-Ne Laser, the efficiencies of the
silicon cells were improved by about 50% compared to operation
in sunlight. The improvement in efficiency could have conceivably
been increased to about 90% if an optimum wavelength laser
were used. Efficiencies of GaAs cells also were improved about
50% but could perhaps have been increased to about 130%
with an appropriate laser. Author

N72-33061# Jet Propulsion Lab., Calif. Inst. of Tech.,
Pasadena. Guidance and Control Div.

PHOTOVOLTAIC SOLAR ARRAY TECHNOLOGY REQUIRED FOR THREE WIDE SCALE GENERATING SYSTEMS FOR TERRESTRIAL APPLICATIONS: ROOFTOP, SOLAR FARM, AND SATELLITE

Paul A. Berman 15 Oct. 1972 27 p refs

(Contract NAS7-100)

(NASA-CR-128381; JPL-TR-32-1573) Avail: NTIS HC \$3.50
CSCL 10A

Three major options for wide-scale generation of photovoltaic
energy for terrestrial use are considered: (1) rooftop array, (2)
solar farm, and (3) satellite station. The rooftop array would use
solar cell arrays on the roofs of residential or commercial
buildings; the solar farm would consist of large ground-based
arrays, probably in arid areas with high insolation; and the
satellite station would consist of an orbiting solar array, many
square kilometers in area. The technology advancement
requirements necessary for each option are discussed, including
cost reduction of solar cells and arrays, weight reduction,
resistance to environmental factors, reliability, and fabrication
capability, including the availability of raw materials. The majority
of the technology advancement requirements are applicable to all
three options, making possible a flexible basic approach regardless
of the options that may eventually be chosen. No conclusions
are drawn as to which option is most advantageous, since the
feasibility of each option depends on the success achieved in the
technology advancement requirements specified. Author

A73-22440

Passive solar array orientation devices for
terrestrial application. J. W. Fairbanks (NASA, Goddard Space Flight
Center, Space Power Technology Branch, Greenbelt, Md.) and F. H.
Morse (Maryland, University, College Park, Md.). Solar Energy, vol.
14, Dec. 1972, p. 67-79, 9 refs.

A passive solar array orientation device, called a thermal
heliotrope, is described, and several terrestrial applications are
illustrated. The thermal heliotrope consists of a bimetallic helical coil
that serves as the motor element, producing torque and angular
displacement. A control mechanism in the form of one or more
shades completes the basic device. In comparison with electro-
mechanical tracking systems, the thermal heliotrope is electrically
passive, has relatively few parts, and is low cost. After describing the
principle of operation and several models built for space applications,
the design considerations for several terrestrial thermal heliotrope
units are presented. It is suggested that the use of the thermal
heliotrope for solar array orientation could significantly reduce array
cost, thereby increasing the competitive economic posture of solar
arrays for terrestrial applications. The thermal heliotrope, modified
for terrestrial use is readily adaptable to orient solar energy
concentrators, such as furnaces and stills. (Author)

(NP-19658) AN INQUIRY INTO BIOLOGICAL ENERGY CONVERSION. Hollander, A.; Monty, K. J.; Pearlstein, R. M.; Schmidt-Bleek, F.; Snyder, W. T.; Volkin, E. (Tennessee Univ., Knoxville). Dec 1972. 42p.

Three promising areas in which biological processes might be applied to the effort to expand energy supplies were explored. Alkal or microbial photosynthesis could be used to produce molecular hydrogen, with water as the primary source of atomic hydrogen and sunlight as the energy source. The economics of hydrogen production by photosynthesis involve the large-scale growth of algae (and/or bacteria), for which some parameters have already been measured, the obvious investment of the land areas large enough to trap the required solar energy, and such unknown details as the cost and lifetime of isolated enzyme reactors and the ultimate efficiency of managed populations of organisms. The second possibility is the production of methane by certain groups of bacteria that are able to reduce alcohols, aldehydes, or carboxylic acids during anaerobic growth, with methane as a major fermentation product. The economics of such processes will be related to the regional availability of large quantities of suitable organic wastes and the availability of a moderate-temperature heat source. The third area involves the use of microorganisms to facilitate the processing of certain fossil fuels that heretofore have been considered economically untouchable such as the bacterial oxidation of the sulfur indigenous to certain shale deposits and biological attacks to convert tarry deposits to more tractable chemical forms. (JCW)

TITLE: Some Problems Associated with Large Scale Production of Electrical Power from Solar Energy via the Photovoltaic Effect

AUTHOR: Lofetski, J.J.

CORPORATE AUTHOR: Brown University

ADDRESS: Providence, RI

PUBLICATION DESCRIPTION: Paper No. 72-WA/Sol-4, contributed by the Solar Energy Applications Group of The American Society of Mechanical Engineers for presentation at the Winter Annual Meeting, New York, NY, November 26-30, 1972, 4 p.

PUBLICATION DATE: 1972

ABSTRACT: This paper explores some questions associated with large-scale solar energy conversion via photovoltaic solar cells. It is shown that about 0.1 percent of the land area of the United States would have to be covered by 10 percent efficient solar cells to produce all the electrical energy currently consumed in the United States. Various technologically feasible methods of storing large amounts of electrical energy are discussed. The cost goals which must be met by solar arrays intended for large systems are summarized, and methods of achieving these goals are considered. (Auth) **AVAILABILITY:** The American Society of Mechanical Engineers, United Engineering Center, 345 East 47th St., New York, NY 10017 (\$3.00 per copy, \$1.00 to ASME members)

TITLE: A Briefing on Solar Power Farms
AUTHOR: Weinel, A.B.; Weinel, M.P.
CORPORATE AUTHOR: Arizona, University of, Optical Sciences Center

PUBLICATION DESCRIPTION: Briefing to the Task Force on Energy of the House of Representatives Committee on Science and Astronautics, 33 p.

PUBLICATION DATE: 1972, March 6

ABSTRACT: We have embodied our studies over the past two years into a new concept that we wish to talk about today. We feel that thermal conversion of solar energy into electrical power at efficiencies approaching 30% is possible using current technology borrowed from USAF, NASA, and AEC programs. Our study also indicates that the economics of solar power by means of our concept appear to be comparable to the generation of power today using natural gas as a fuel. We are encouraged to advise you that our solar power concept provides a new energy option with the same target date as the breeder reactor; namely, the first half of the decade of the 80's. We further feel that the cost of a development program up to a demonstration power system in the several-hundred-megawatt size will be substantially less than has been invested to date in either the breeder or the CTR (controlled thermonuclear reactor) programs. We also wish to show that solar power has the potential of sustaining the entire power needs of the United States within reasonable uses of land area for this purpose. We recommend, however, that solar power be considered today as a regional solution until the long-distance power transmission problem is solved. We would like to present material to you today to substantiate these summary statements. (Auth)

TITLE: Solar Energy - The Possible Dream?

AUTHOR: Weinel, A.B.; Weinel, M.P.
CORPORATE AUTHOR: Arizona, University of, Optical Sciences Center

PUBLICATION DESCRIPTION: Astate, 3-5

PUBLICATION DATE: 1972, February

ABSTRACT: A method of converting solar energy to electricity is described, which uses optical thin film coatings to absorb sunlight and prevent re-emission of heat. The system uses conventional steam turbines to generate electricity and low temperature salt eutectics to store solar heat overnight or on cloudy days. (NPG)

PUBLICATION DESCRIPTION: Paper presented at the Annual Meeting of the American Physical Society and American Association of Physics Teachers, San Francisco, CA: 15 p.

PUBLICATION DATE: 1972, February 2

ABSTRACT: A solar power system is described, which uses thermal conversion with a thermodynamic cycle. The system consists of a solar collecting area, a thermal storage sub-system, and a standard steam turbine power plant. Four key technologies will be used by the system: optical thin film coatings to absorb sunlight and prevent re-emission of heat; liquid metal heat transfer; medium-temperature salt electrolytic and mass production. It is estimated that a solar power farm of 5000 square miles could generate 1,000,000 Mw. The power plants in the Four Corners area require more land for strip mining than is required by the solar farm. A development time scale is presented. A solar power farm producing 500 to 1000 Mw could be in operation by 1985. (MPS)

TITLE: A Harvest of Solar Energy

AUTHOR: Meinel, A.B.: Meinel, W.P.

**CORRESPONDING AUTHOR: ARIZONA, UNIVERSITY OF, OPTICAL
SCIENCES CENTER**

PUBLICATION DESCRIPTION: Paper presented at the
 Period Conference on the Energy Crisis, Las
 Cruces, NM, 19 P.

PUBLICATION DATE: 1972, MAY 5

ABSTRACT: The notion that we feel is a major new contender is solar power. We would like to describe our concept of a solar power system and a time scale for development that can make solar power facts a reality on the national scene in 1985, through a development program of conservative scale. (auth)

TTTTT: Solar Energy - Is It a Feasible Option?

AUTHOR: Meinel, A. B.: Meinel, W. B.

CORPORATE AUTHOR: ARIZONA, UNIVERSITY OF, OPTICAL
 SCIENCES CENTER

PUBLICATION DESCRIPTION: Paper presented at the Symposium of the Forum on Physics and Society, American Physical Society, Albuquerque, NM: 33 p.

RECEIVED DIRECTOR, FBI, JUNE 5 1962

ABSTRACT: Solar power is believed to be a major contender among the new energy options such as breeder reactors, fusion power, coal gasification, and geothermal power. A solar power system using thermal conversion is described. Power from solar energy would probably cost 30% more than power from nuclear plants or plants using strip-mined coal. Solar power farms located in the desert will not change the thermal balance of the area. A method of using solar energy to provide power for peak demands is outlined.

ENERGY PLANTATION. Szego, G. C.; Fox, J. A.; Eaton, D. R. pp 1131-1134 of 7th Intersociety Energy Conversion Engineering Conference. Washington; American Chemical Society (1972).

From 7th Intersociety energy conversion engineering conference; San Diego, California, USA (25 Sep 1972). See CONF-720925-.

The solar energy falling on the Earth is far in excess of the rates of usage of energy from all sources. The main problems with solar energy are intermittency and low density. The use of photosynthesis on a planned operational scale seems to solve these problems in a cost-effective fashion, indeed highly competitive with coal, and at the same time does not require inordinate land areas. Technical and economic scenarios and analyses that compare the cost of a million Btu delivered with that for fossil fuels and nuclear energy sources are presented. (auth)

LARGE SCALE SOLAR ELECTRIC POWER GENERATION: Ralph, E. L. (Textron, Sylmar, CA). Solar Energy: 14: No. 1, 14-20 (Dec 1972).

The need for a source of energy for generating electric power has been well established. This new energy source must be able to meet the many demands of our society in respect to resource depletion, increased electrical power requirements, peak demands, site location, low costs, and the elimination of pollution. The one energy source that provides a solution to these problems is solar energy. Although no significant effort or funds are being spent on solar energy research, there are indications that this energy could be tapped with present day technology.

A73-14253 Solar arrays for terrestrial applications and sounding balloons. Y. Saltes (Radiotechnique-Compelco, Suresnes, Hauts-de-Seine, France). In: Photovoltaic Specialists Conference, 9th, Silver Spring, Md., May 2-4, 1972, Record. (A73-14203 03-03) New York, Institute of Electrical and Electronics Engineers, Inc., 1972 p.382-385.

Review of the technical evolution which has led to the present type of solar land generators. The results of the operation of solar energy plants in various parts of the world are cited, noting some technological problems caused by the environment and the solutions proposed. An evaluation is made of the future prospects for solar generators, and, in particular, an estimate is made of the cost of generating energy by means of solar cell arrays. In addition, three types of solar generators for powering the gondolas attached to sounding balloons are described.

N72-19057*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
LARGE-SCALE TERRESTRIAL SOLAR CELL POWER GENERATION COST: A PRELIMINARY ASSESSMENT
 Adolph E. Spakowski and Lloyd I. Shure Mar. 1972 13 p refs
 (NASA-TM-X-2520; E-6675) Avail: NTIS CSCL 10A

A cost study was made to assess the potential of the large-scale use of solar cell power for terrestrial applications. The incentive is the attraction of a zero-pollution source of power for wide-scale use. Unlike many other concepts for low-pollution power generation, even thermal pollution is avoided since only the incident solar flux is utilized. To provide a basis for comparison and a perspective for evaluation, the pertinent technology was treated in two categories: current and optimistic. Factors considered were solar cells, array assembly, power conditioning, site preparation, buildings, maintenance, and operation. The capital investment was assumed to be amortized over 30 years. The useful life of the solar cell array was assumed to be 10 years, and the cases of zero and 50-percent performance degradation were considered. Land costs, taxes, and profits were not included in this study because it was found too difficult to provide good generalized estimates of these items. On the basis of the factors considered, it is shown that even for optimistic projections of technology, electric power from large-scale terrestrial use of solar cells is approximately two to three orders of magnitude more costly than current electric power generation from either fossil or nuclear fuel powerplants. For solar cell power generation to be a viable competitor on a cost basis, technological breakthroughs would be required in both solar cell and array fabrication and in site preparation.

Author

A73-18028 Electrical and isotope power from space for terrestrial use. T. B. Taylor (International Research and Technology Corp., Washington, D.C.). (New York Academy of Sciences, Conference on Planetology and Space Mission Planning, 3rd, New York, N.Y., Oct. 28-30, 1970.) New York Academy of Sciences, Annals, vol. 187, Jan. 25, 1972, p. 420-426.

The concept of an orbital facility for converting solar energy to stored fission energy for use in terrestrial power plants is reviewed in terms of overall system parameters and economics. It is suggested that the concept is worth studying in considerably greater detail.

M.V.E.

N72-27055*# National Academy of Sciences-National Research Council, Washington, D.C. Ad Hoc Panel on Solar Cell Efficiency.

SOLAR CELLS: OUTLOOK FOR IMPROVED EFFICIENCY
 1972 78 p refs
 (Contract NSR-09-012-903)
 (NASA-CR-127234) Avail: NTIS HC \$6.00 CSCL 10A

Studies are reported on the technical feasibility of increasing the efficiency of solar cells for use in space programs.

N72-26034*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena, Guidance and Control Div.
CONSIDERATIONS WITH RESPECT TO THE DESIGN OF SOLAR PHOTOVOLTAIC POWER SYSTEMS FOR TERRESTRIAL APPLICATIONS

Paul A. Berman 15 Jun. 1972 16 p refs
 (Contract NAS7-100)
 (NASA-CR-127031; JPL-TR-32-1558) Avail: NTIS HC \$3.00 CSCL 10A

The various factors involved in the development of solar photovoltaic power systems for terrestrial application are discussed. The discussion covers the tradeoffs, compromises, and optimization studies which must be performed in order to develop a viable terrestrial solar array system. It is concluded that the technology now exists for the fabrication of terrestrial solar arrays but that the economics are prohibitive. Various approaches to cost reduction are presented, and the general requirements for materials and processes to be used are delineated.

Author

Vermishev, K. Kh., "Some Problems in the Long Range Forecasting of Power Generation and Solar Energy Utilization", Applied Solar Energy, V. 6, p. 1, 1972.

QC715. P48 1972

A73-14203 Photovoltaic Specialists Conference, 8th, Silver Spring, Md., May 2-4, 1972, Record. Conference sponsored by the Institute of Electrical and Electronics Engineers, New York, Institute of Electrical and Electronics Engineers, Inc., 1972. 400 p. Members, \$15.; nonmembers, \$20.

Topics discussed include new developments in silicon solar cells, Cu₂S-CdS and other compound solar cells, solar cell module technology, space applications of solar cells, space environmental effects on solar cell operation, and terrestrial applications of solar cell arrays. In particular, studies are made of the solar cells used for the Helios sun probe, the flight of a sun-tracking flexible rolled-up solar array, and the solar array system for the Skylab orbital workshop. Also, the results of studies of the role of lithium additives in annealing radiation-induced defects in silicon solar cells are presented.

Title: Harnessing the Sun's Energy
 AUTHOR: Thomsen, D.E.
 PUBLICATION DESCRIPTION: Science News, 101(15),
 237-238
 PUBLICATION DATE: 1972, April 8
 ABSTRACT: The two nonphotosynthetic ways to use
 solar energy are to concentrate the sun's
 rays to heat something or use the
 photovoltaic effect. Suggestions to use a
 square-mile array of photovoltaic collectors
 on Earth or use them in an orbital power
 plant are described. Another suggestion is
 to use optical films to concentrate light and
 heat a liquid, probably sodium, to generate
 steam to drive turbines. Proponents of solar
 energy believe it could provide up to 20% of
 the world's power. (NPG)

NTIS-11086// Army Foreign Science and Technology Center,
 Charlottesville, Va.
 CONTEMPORARY STATUS OF STUDIES ON DIRECT
 CONVERSION OF SOLAR ENERGY TO ELECTRICAL
 ENERGY
 N. S. Lidorenko 28 Jul 1972 11 p refs Transl into ENGLISH
 from Geotekhnika (Tashkent), no. 6, 1969 p 3-8
 (AD-747293; FSTC-MT-23-1429-71) Avail: NTIS CSCL 10/2
 Photoelectric, thermoelectric and thermomission methods
 of direct conversion of solar energy into electric energy are studied.
 The article presents a review of modern methods of investigation.
 Author (GRA)

CM-140,620 1971 PROCEEDINGS OF THE ROUND TABLE DISCUSSION ON THE GROUND APPLICATION OF PHOTOVOLTAIC POWER SOURCES - 4TH. Apr.8,1971. 63p.

Boston College,
 Chestnut Hill, Mass.
 Conference on the Technology of Apr.8,
 Solar Cells for Ground Power 1971
 Sources

Introduction
 R. L. Carovillano

Solar Power for Ground Application
 William R. Woodward, NASA Headquarters
 (paper not received)

Environmental and Economic Aspects of Solar Electrical Power 3
 R. F. Girvan and Helen J. Young

Storage Batteries 22
 Mark Solomon

A New Silicon Solar Cell Structure for Large Scale Production 43
 P. H. Fang

Cadmium Sulfide Solar Cells for Terrestrial Applications 53
 Alan G. Stanley

A New Heterojunction Solar Cell-System 62
 P. H. Fang and J. H. Chen

N71-23700* # National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.

THE GENERATION OF POLLUTION FREE ELECTRICAL POWER FROM SOLAR ENERGY Also: A72-15892 #

William R. Cherry Mar. 1971 18 p refs
(NASA-TM-X-65497; X-760-71-135) Avail: NTIS CSCL 10B

A study is reported to determine the feasibility of electrical power plants, utilizing solar energy, to meet future US power demands. Investigation of a pollution free method using photovoltaics on the ground indicates that sunlight falling on about 1% of the land area of the 48 states could provide the total electrical power requirements of the U.S. in the year 1990. In addition, the findings indicate that while the cost of producing solar arrays by today's methods prohibits their use for large-scale terrestrial plants, the cost may become acceptable as conventional fuels become scarcer and more expensive.

D.L.G.

See also: J. Eng. Power, V.94, ser.A, no.2, Apr. 1972, p.78-82.

SOLAR CELLS. Proceedings of the International Colloquium, Toulouse, France, July 6-10, 1970. New York: Gordon and Breach, Science Publishers, Inc. (1971). 659p. (CONF-700707-1). \$29.50.

Forty-nine papers were presented at the conference. A separate abstract was prepared for each of eight. The remaining forty-one papers and reports of four working groups were not within the scope of NSA. (TF9)

A72-15893* # Terrestrial adaptation of the thermal helioprope. J. W. Fairbanks (NASA, Goddard Space Flight Center, Space Power Technology Branch, Greenbelt, Md.) and F. H. Morse (Maryland, University, Silver Spring, Md.). American Society of Mechanical Engineers, Winter Annual Meeting, Washington, D.C., Nov. 28-Dec. 2, 1971, Paper 71-WA/Sol-10. 10 p. 9 refs. Members, \$1.00; nonmembers, \$3.00.

The principle of using bimetal helical coils to cause solar arrays to track the sun in space is presently under consideration for array orientation on several spacecraft. Adaptation of this thermal helioprope to terrestrial applications introduces additional design considerations. The dominance of solar-radiation energy input to the helical coil over convective energy losses has to be ensured, and wind effects must be minimized. As long as the cost of solar cells remains high, orientation will always result in a significant cost saving for the converter.

G.R.

A72-15891 # A proposed new concept for a solar-energy converter. R. L. Bailey (Florida, University, Gainesville, Fla.). American Society of Mechanical Engineers, Winter Annual Meeting, Washington, D.C., Nov. 28-Dec. 2, 1971, Paper 71-WA/Sol-1. 5 p. 7 refs. Members, \$1.00; nonmembers, \$3.00. Research supported by the University of Florida.

The possibilities are explored to create high efficiency solar-electricity converters utilizing the wave-like properties of radiation interacting with absorber-converter elements. The concept is based on the feasibility of extending principles of power absorbing antennas and converters to the visible light range. The resulting proposed converter structure would have a rough surface texture and yield a dc output. It may have significant efficiency, cost, and fabricating advantages, particularly for large-scale terrestrial utilization of solar energy. The concept is called an Electromagnetic Wave Energy Converter.

G.R.

N73-33011# Army Foreign Science and Technology Center, Charlottesville, Va.

SOLAR AND WIND POWER TO BE HARNESSSED

Ya. Shefer, G. Akhtensko, N. Lidorenko, S. Kostyan, and A. Shakhov 1 Nov. 1972 6 p Transl. into ENGLISH from Pravda (Moscow), 11 May 1971 p.3

(AD-765783; FSTC-HT-23-922-72) Avail: NTIS CSCL 10/2
The state-of-the-art of wind and solar power installations are discussed. GRA

TITLE: Is it Time for a New Look at Solar Energy?
AUTHOR: Meinel, A.H.; Meinel, R.P.
CORPORATE AUTHOR: University of Arizona, Optical Sciences Center, Tucson, Arizona
PUBLICATION DESCRIPTION: Bulletin of the Atomic Scientists, 27(6), 6 p.

PUBLICATION DATE: 1971, October
ABSTRACT: The possibilities of converting solar energy to electrical energy have been explored in great detail and one method which seems practical is outlined in some detail. The solar energy would be collected in special films which maximize visible light absorption and minimize infrared radiation. The heat would be transferred from the collectors to large heat storage tanks by means of a liquid metal. The storage system would compensate for the variable nature of the solar input. Heat from the storage tanks would be removed and used to drive conventional steam turbines. Many engineering details remain to be evaluated. (JWC)

72 Space technology and earth problems. Edited by C.
787 Quentin Ford. Tarzana, Calif., Distributed by the
AAS Publications Office [1970]
xvi, 401 p. illus. 25 cm. (AAS science and
technology series, v. 23).

An American Astronautical Society publication.
Proceedings of an AAS symposium held Oct. 23-25,
1969, at Las Cruces, N.M. **P. 266.**

UNLIMITED WATER AND POWER WITH SOLAR ENERGY ENERGIZING ELECTRONIC, STEAM, AND TURBINES IN SYSTEMS

*
John F. Crane

The vast quantity of solar radiant energy heretofore untapped can now be harnessed to provide unlimited amounts of fresh water through the conversion of sea water, brackish and polluted water. Steam derived from the conversion process can be utilized to provide unlimited power.

Cosmic and electronic frequencies can destroy and remove undesirable media present in water and in food. This may be invaluable to man when he travels in outer space and in his control of media which may cause illness and death.

New counter-rotating turbines, both gas and steam types, provide higher shaft horsepower with new balanced propulsion and without end thrust on bearings. Turbines which give higher efficiencies are presented as better prime movers.

Solar methods utilizing free solar heat up to 6000 deg. F appear to be the best answer to provide smog-free energy. Conveyors used with solar heat can be applied to handle sewage and reduce all odors to zero. Similar methods can be applied to mining and to the recovery of metals and to the pumping of water across the nation on a "free" solar energy basis which can operate around the clock by using stored hot brine to supplement solar radiation by means of insulated reservoirs. Infrared heat may also be used instead of solar heat.

For complete paper, see AAS69-611, microfiche supplement (Vol. 12, AAS Microfiche Series).

72N72164# TYPE 9/2/6 BNL-16259 CONF-711035-1 70/00/00 6 PAGES UNCLASSIFIED
DOCUMENT

HYDROGEN FOR ENERGY TRANSPORT AND STORAGE IN SOLAR ENERGY SYSTEMS
A/HOFFMAN, K. C.; B/WINSCHKE, W. E.
BROOKHAVEN NATIONAL LAB., UPTON, N.Y.
SPONSORED BY AEC PRESENTED AT THE 3D CONF. ON LARGE SCALE SOLAR
ENERGY CONVERSION FOR TERRESTRIAL USE, NEWARK, DEL., 9 OCT. 1971
/♦ENERGY TRANSFER/HYDROGEN♦SOLAR ENERGY/ ENERGY STORAGE/ SOLAR
ENERGY ABSORBERS/ SOLAR GENERATORS

LARGE SOLAR INSTALLATIONS. THEIR PROPERTIES AND
PROSPECTS. Ya. T. Shermazanyan, et al.
Applied Solar Energy, v.5, no.5, 1969, p.42-50.

Solar Energy, Vol. 12, pp. 51-64. Pergamon Press, 1968. Printed in Great Britain

PILOT PLANTS OF SOLAR STEAM GENERATING STATIONS

G. FRANCIA*

(Received 21 February 1968)

Abstract - We describe here a way to use honeycomb panels (anti-radiating cellular structure). The paper was first submitted to the United Nations Conference on New Sources of Energy held in Rome in 1961. In our research we have used plants for the thermo-dynamic conversion of solar energy into electric energy at high temperatures. We refer to the boilers at Marsilles and Genoa, and we describe briefly the plant being built in St. Ilario at Nervi, Genoa. This plant has a maximum production of 140 kg/hr of steam at 180 atm, while in the temperature range 500-650°C.

DESIGN OF SOLAR CELLS FOR TERRESTRIAL USE.

P.A. Berman.

Solar Energy, v.11, 1967, p.180-185

The various aspects that must be considered to successfully design solar cells for terrestrial systems are presented. Some of the more recent developments in solar cell technology are mentioned. It is concluded that the most logical approach to the use of silicon solar cells for terrestrial applications is to utilize solar concentrators in conjunction with cells specially designed for such operations. The factors that affect solar cell performance are discussed, and an experiment is described that optimizes the most important parameters for obtaining the best performance at intensities of between 100 and 400 milliwatts per square centimeter. The characteristics of such optimized cells are compared with the more common cell designs with regard to the various electrical parameters. A discussion of cell-concentrator systems is presented and some cost estimates are given.

1966

A67-20288 =
STORAGE OF SOLAR ELECTRICAL ENERGY BY ELECTROLYSIS OF WATER, SEPARATE STORAGE OF COMPRESSED HYDROGEN AND OXYGEN, AND SUBSEQUENT RECOMBINATION OF THESE GASES BY FUEL CELLS.

E. Justi and W. Kalberlah (Braunschweig, Technische Hochschule, Institut für technische Physik, Braunschweig, West Germany). (Coopération Méditerranéenne pour l'Energie Solaire, Rencontre Générale de Printemps, Université de Marseille, Marseille, France, May 19-25, 1966, Article.)

Coopération Méditerranéenne pour l'Energie Solaire, Bulletin no. 11, Dec. 1966, p. 105-111.

Discussion of the collection of solar energy by means of hydrogen fuel cells operating at ambient temperature and pressure, with high efficiency and power density, with water as the harmless final reaction product. Only such common metals as nickel and silver are used as catalysts, and methods have been found to increase their catalytic activity according to Raney's methods. The electrodes described have a double skeleton. A new three-electrode storage cell and an experimental demonstration model are described. The energy and efficiency of storing is considered.

F.R.L.

N64-29491 Oklahoma State U., Stillwater
THE BASIC TECHNICAL PROBLEMS ASSOCIATED WITH A SOLAR TO ELECTRICAL SYSTEM WITH INTERMEDIATE ENERGY STORAGE

C. M. Summers In its Proc. of a Conf. on Energy Conversion and Storage p 89-95 (See N64-29484 21-06) Okla. State U.: \$5.00

The five basic groups of components for a proposed pilot-plant operation, based on solar to electrical energy conversion with intermediate energy storage, are listed. The technological problems associated with each group include these: (1) the solar (in this case, wind energy) to electrical energy transducer; (2) the electrolysis and storage system; (3) the fuel cell; (4) the solid-state inversion system; and (5) reversion components to convert electrical energy to a fuel storage.

M.P.G.

N64-29486 Oklahoma State U., Stillwater
A QUANTITATIVE EVALUATION OF POWER DENSITY AND STORAGE CAPACITY FOR SOLAR AND WIND ENERGY
C. M. Summers In its Proc. of a Conf. on Energy Conversion and Storage p 15-33 (See N64-29484 21-06) Okla. State U.: \$5.00

Increasing efficiencies of fuel cells that convert and reconvert hydrogen and oxygen fuel and electricity directly makes the age-old dream of utilizing solar energy more feasible. Calculations of the annual mean power-density value, of the efficiency of solar conversion units, and of the storage capacity required show that this method is not economically feasible at present. The same calculations made for wind energy (another form of solar energy) show that wind energy conversion is technically and economically feasible. A comparison of solar-energy and wind-energy power-density data shows that in those months when the sunlight is above average, the wind

1963

N63-19875 P. E. C. Corp., Boulder, Colo.
 INVESTIGATION FOR THE PURPOSE OF IMPROVING THE
 EFFICIENCY OF UTILIZATION OF SOLAR ENERGY BY THE
 DECOMPOSITION OF WATER INTO HYDROGEN AND OXY-
 GEN [Final Report 1 May 1961-30 Apr. 1963]
 Ronald E. West, Hoemooz Mahmoud, Donald G. Burkhard,
 Harumasa Ito, and Robert S. Kirk May 1963 144 p 91 refs
 (Contract AF 19(604)-8420)
 (AFRL-63-668)

The sensitized photo-decomposition of water has been
 studied, with the purpose of improving its efficiency as a means
 of solar energy conversion. A number of metallic cations and
 other materials were tested for sensitizer activity and, of these,
 only ceric, thallic, ferrous, iodide, and chromous ions do sensi-
 tize the reaction, the former two to yield oxygen, the latter three
 hydrogen. In no case was the simultaneous production of
 hydrogen and oxygen observed. Quantum yields were deter-
 mined, with substantial conversion of the sensitizer, and found
 to be of the order of 10^{-2} to 10^{-4} . Initial yields were much
 higher. With the known sensitizers, this reaction does not
 utilize a sufficient fraction of the solar spectrum to be practical
 as a means of solar-energy conversion. Several mixtures of ions
 and also various solid materials as additives to sensitizer solu-
 tions were tested for their influence on sensitizer activity. In
 every case, it was found that the quantum yield was the same
 as or lower than with the sensitizer alone.

Author

1963

N64-17379

Army Signal Research and Development Lab., Fort Monmouth, N.J.
 Electronic Components Dept.

SOLAR POWER SUPPLIES FOR GROUND USE

George Hunrath In Its Proc., 17th Ann. Power Sources Conf.
 [1963] p 8-11 refs (See N64-17376 09-06)

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1974

N74-17784* # Little (Arthur D.), Inc., Cambridge, Mass.
FEASIBILITY STUDY OF A SATELLITE SOLAR POWER STATION Final Report
 Peter E. Glaser, Owen E. Maynard (Raytheon Co., Sudbury, Mass.), John Mackovciak, Jr. (Grumman Aerospace Corp.), and Eugene L. Ralph (Spectrolab, Inc., Sylmar, Calif.) Washington NASA Feb. 1974 199 p refs
 (Contract NAS3-16804)
 (NASA-CR-2357; ADL-C-74830) Avail: NTIS HC \$5.50 CSCL 10A

A feasibility study of a satellite solar power station (SSPS) was conducted: (1) to explore how an SSPS could be "flown" and controlled in orbit; (2) to determine the techniques needed to avoid radio frequency interference (RFI); and (3) to determine the key environmental, technological, and economic issues involved. Structural and dynamic analyses of the SSPS structure were performed, and deflections and internal member loads were determined. Desirable material characteristics were assessed and technology developments identified. Flight control performance of the SSPS baseline design was evaluated and parametric sizing studies were performed. The study of RFI avoidance techniques covered: (1) optimization of the microwave transmission system; (2) device design and expected RFI; and (3) SSPS RFI effects. The identification of key issues involved (1) microwave generation, transmission, and rectification and solar energy conversion; (2) environmental-ecological impact and biological effects; and (3) economic issues. The feasibility of the SSPS based on the parameters of the study was established. Author

A73-39247 # Solar power via satellite. P. E. Glaser (Arthur D. Little, Inc., Cambridge, Mass.). *Astronautics and Aeronautics*, vol. 11, Aug. 1973, p. 60-68, 29 refs.

The satellite solar power station (SSPS) concept is described and shown to represent a major challenge to engineering and an unparalleled opportunity to apply space technology for the benefit of mankind. Its feasibility is contingent upon no fundamental breakthroughs. Whether it is worth being realized is shown to depend upon criteria of comparative cost, resource conservation, or environmental enhancement that may vary in the future as technology developments provide new energy production alternatives. It is felt that the necessary steps to protect the SSPS option should be taken in the meantime.

1973

A74-24942 Space solar power. P. E. Glaser (Arthur D. Little, Inc., Cambridge, Mass.). In: Photovoltaic power and its applications in space and on earth: International Congress on the Sun in the Service of Man, Paris, France, July 2-6, 1973, Proceedings. (A74-24901 10-03) Brétigny-sur-Orge, Essonne, France, Centre National d'Etudes Spatiales, 1973, p. 599-618, 47 refs.

The results of work carried out on a satellite solar power station (SSPS) since the concept was presented at the 1968 Solar Energy Conference are reviewed. The objective of this concept is to supply electrical power on the earth to provide an economically viable and environmentally and socially acceptable alternative to other energy production methods. The principle on which the SSPS is based relies on solar energy conversion in a satellite in synchronous orbit to produce electricity. This electricity is fed to microwave generators arranged to form an antenna which directs a beam to a receiving antenna on earth, where the microwave energy is efficiently and safely converted back to electricity. (Author)

1973

TL 787. A62 V.31

A74-14465 Solar power for our nation. T. J. Kelly and J. Mockovciak, Jr. (Grumman Aerospace Corp., Bethpage, N.Y.). In: The second fifteen years in space: Proceedings of the Eleventh Goddard Memorial Symposium, Washington, D.C., March 8, 9, 1973. (A74-14463 03-34) Tarzana, Calif., American Astronautical Society, 1973, p. 39-54, 6 refs.

With increasing attention focusing on the energy problem, considerable interest has recently surfaced relative to the potential use of solar energy as a power source for our nation. This paper assesses the possibilities for near-term and longer-range applications of solar energy, including a large space-based Satellite Solar Power Station. Many applications are well beyond the research phase and could be accelerated to commercial readiness. Longer-range applications should be pursued with appropriate technology development programs to provide this nation with energy options in the future. If the nation wants to use solar energy as a major power source, it is technically possible to do so. Further, with appropriate incentives and government support, the public can have this clean and abundant energy source economically. (Author)

METHOD AND APPARATUS FOR CONVERTING SOLAR RADIATION TO ELECTRICAL POWER. Glaser, P. E. (to Arthur D. Little, Inc.). US Patent 3,781,647. 25 Dec 1973. Filed date 26 Jul 1971. 14p.

Solar radiation is collected and converted to microwave energy by means maintained in outer space on a satellite system. The microwave energy is then transmitted to Earth and converted to electrical power for distribution. (Official Gazette)

A73-23801 Satellite power stations - A new source of energy. W. C. Brown (Raytheon Co., Lexington, Mass.). IEEE Spectrum, vol. 10, Mar. 1973, p. 38-47. 30 refs.

It has been suggested by Glaser (1968) that large arrays of solar photovoltaic cells should be placed into space in near-equatorial synchronous orbit where the sun would shine upon them nearly 100 per cent of the time. The dc power obtained from the photovoltaic arrays would then be converted into microwave power, beamed to the surface of the earth, and there converted back into dc power. This concept has become known as the Satellite Solar Power Station (SSPS). The system configuration and characteristics of the SSPS are discussed together with the solar photovoltaic cell array, details of the microwave power transmission system, and side effects of the SSPS system. G.R.

A73-38404 # Feasibility of large-scale orbital solar/thermal power generation. J. T. Patsa and G. R. Woodcock (Boeing Co., Seattle, Wash.). In: Intersociety Energy Conversion Engineering Conference, 8th, Philadelphia, Pa., August 13-16, 1973, Proceedings. (A73-38386 19-03) New York, American Institute of Aeronautics and Astronautics, Inc., 1973, p. 312-319. 21 refs.

Discussion of a thermal conversion concept which is potentially feasible with today's solar concentrator technology and component efficiencies, if the low earth orbit transportation cost is approximately \$60/lb. The system is also potentially feasible with space shuttle transportation cost of approximately \$160/lb and 1980 component efficiencies if the solar concentrator can be constructed at approximately 0.03 lb/sq ft. The above conclusions are based on a projected competitive busbar value of electrical energy of 2 to 3 cents per kilowatt-hour. Projections indicate that launch systems technology can be expected ultimately to attain transportation costs as low as \$10/lb for low earth orbit missions. This value contributes \$25 per kilowatt of system capital cost. (Author)

See also: J. Spacecraft, V.11, no. 6, June '74, p. 409-

582

The satellite solar power station. P. E. Glaser (Arthur D. Little, Inc., Cambridge, Mass., USA). 1973 IEEE G-MTT International Microwave Symposium. Digest of Technical Papers, Boulder, Colo., USA, 4-6 June 1973 (New York, USA: IEEE 1973), p. 18-8.

The feasibility of power production on Earth by means of a satellite solar power station is discussed. The status of technology to achieve solar energy conversion, microwave generation, transmission and rectification and transportation to synchronous orbit is reviewed, and costs for the system and components are presented. (5 refs.)

HD 9540.4.15 RM3
A73-38313 Solar power via satellite. P. E. Glaser (Arthur D. Little, Inc., Cambridge, Mass.). In: Institute of Electrical and Electronics Engineers, International Convention and Exposition, New York, N.Y., March 26-30, 1973, Technical Papers. (A73-38298 17-09) New York, Institute of Electrical and Electronics Engineers, Inc., 1973, p. 8/4-1 to 6/4-10. 24 refs.

There is justification for a reexamination of the potential of solar energy because among the different sources of energy, whether they be nonrenewable, such as fossil or nuclear fuels, or continuous, such as tidal or geothermal, none has a greater potential or represents, at least in mankind's terms, a more constant and inexhaustible energy source. The most favorable conditions for solar energy conversion are out in space in an orbit around the sun. The development of an economic earth-to-orbit transportation system based on the space shuttle opens up the option to carry out solar energy conversion in a satellite solar power station (SSPS) in synchronous orbit, with only the final conversion step taking place on the earth. Solar power via satellites could provide an economically viable and socially acceptable option to meet future world energy requirements.

A satellite solar power system (SSPS) can be designed to generate electrical power on earth at specific levels ranging from about 3000 to 15,000 megawatt. Over this range of power output the orbiting portion of the SSPS exhibits the best power-to-weight characteristics. Additional solar collector arrays and antennas could be added to establish an SSPS system at a desired orbital location. With the receiving antenna placed either on land or on platforms over water near major load centers and tied into a power transmission grid, power could be delivered to almost any desired geographic location. F.R.L.

A74-11020 # Satellite solar power stations to meet future energy demands. P. E. Glaser (Arthur D. Little, Inc., Cambridge, Mass.). Industries Atomiques et Spatiales, vol. 17, July-Aug. 1973, p. 77-85. 16 refs. In English and French.

A satellite solar power system (SSPS) can be designed to generate electrical power on earth at specific levels ranging from about 3000 to 15,000 megawatt. Over this range of power output the orbiting portion of the SSPS exhibits the best power-to-weight characteristics. Additional solar collector arrays and antennas could be added to establish an SSPS system at a desired orbital location. With the receiving antenna placed either on land or on platforms over water near major load centers and tied into a power transmission grid, power could be delivered to almost any desired geographic location. F.R.L.

TK 787.A62 V.30

A74-14121 Use of Shuttle in establishing large space installations. K. A. Enricke (North American Rockwell Corp., Space Div., Downey, Calif.). In: Space Shuttle payloads; Proceedings of the Symposium, Washington, D.C., December 27, 28, 1972. (A74-14102 03-31) Tarzana, Calif., American Astronautical Society, 1973, p. 397-447. 23 refs.

Consideration of the feasibility of setting up an orbiting solar reflector and orbiting space power generation and distribution plants. A system called Lunetta, designed for practically useful night illumination of areas of the earth's surface by a reflector in equatorial geosynchronous orbit, is described. The socio-economic value of the Lunetta is stressed by citing the possibility of conducting agricultural activities with its aid at night. Problems connected with the choice of the size, location, and brightness of Lunetta are discussed, as well as problems of weight minimization and radiation-pressure compensation. The possibility of large-scale power generation in space, using nuclear, solar-thermal, and photovoltaic-reflector systems, is considered, as well as a power relay concept involving large antennas in geosynchronous orbit, reflecting and redirecting the energy flow of microwave beams. The ability of the Integrated Space Shuttle configuration selected by NASA and the Geospace Interorbital Transportation vehicle (incorporated in the Shuttle payload and then released in low orbit) to assist in the construction of large installations in geosynchronous orbit is evaluated. A.B.K.

N73-13870* Little (Arthur D.), Inc., Cambridge, Mass. Engineer-
ing Sciences Section. c03
POWER WITHOUT POLLUTION
Peter E. Glaser. In NASA. Marshall Space Flight Center. Space
for Mankind's Benefit 1972 p. 431-439 refs (For availability
see N73-13829 04-30)
CSCL 10B

Details of several methods of converting solar energy to
power without pollution are given. Data cover technical, economic,
and social issues. E.H.W.

A73-15801 # The feasibility of a satellite solar power
station. P. E. Glaser (Arthur D. Little, Inc., Cambridge, Mass.).
American Society of Mechanical Engineers, Winter Annual Meeting,
New York, N.Y., Nov. 26-30, 1972, Paper 72-WA/Sol-6, 5 p. 6 refs.
Members, \$1.00; nonmembers, \$3.00.

The concept of a satellite solar power station which would have
the capability to convert solar energy to microwaves which are
beamed to a receiving antenna to produce power on Earth is
presented. The state-of-the-art of the technology required to achieve
efficient solar energy conversion, microwave power generation,
transmission and rectification is reviewed. Approaches to structural
design, flight control and Earth-to-Orbit transportation are pre-
sented. (Author)

TL 787.A62 V.30

A74-14112 The use of the Space Shuttle to support large
space power generation systems. P. E. Glaser (Arthur D. Little, Inc.,
Cambridge, Mass.). In: Space Shuttle payloads; Proceedings of the
Symposium, Washington, D.C., December 27, 28, 1972. (A74-
14102 03-31) Tarzana, Calif., American Astronautical Society, 1973,
p. 167-191. 18 refs.

The feasibility of obtaining power from space by means of a
satellite solar power station is reviewed. The requirements for a
high-volume transportation system to low earth orbit followed by
delivery of partially assembled components to geosynchronous orbit
for final assembly and deployment are discussed. The steps required
to develop the satellite solar power station are outlined with
emphasis on supporting technology development and verification of
technology readiness. The role of the Space Shuttle in spaceborne
flight verification activities is projected and requirements for Space
Shuttle payloads are indicated. (Author)

A73-22791 Satellite solar power station - An option for
power generation. P. E. Glaser (Arthur D. Little, Inc., Cambridge,
Mass.). In: Intersociety Energy Conversion Engineering Conference,
7th, San Diego, Calif., September 25-29, 1972, Proceedings. (A73-
22751 09-03) Washington, D.C., American Chemical Society, 1972,
p. 507-511. 7 refs.

The principle on which a satellite solar power station (SSPS) is
based is the conversion of solar energy into electricity. This
electricity would be fed to microwave generators arranged to form an
antenna which, in turn, could direct a beam to a receiving station on
the earth where the microwave energy could be efficiently and safely
converted back to electricity to meet baseload power needs. The
status of the technology required to meet the objectives of an SSPS
is discussed. F.R.L.

A73-18027 Space resources to benefit the earth. P. E.
Glaser (Arthur D. Little, Inc., Cambridge, Mass.). (New York
Academy of Sciences, Conference on Planetology and Space Mission
Planning, 3rd, New York, N.Y., Oct. 28-30, 1970.) New York
Academy of Sciences, Annals, vol. 187, Jan. 25, 1972, p. 406-419.
43 refs.

Discussion of the potential benefits that may be derived from
future space missions, with special attention to space as a source of
energy. The possibilities held forth by a satellite solar power station
concept are reviewed in terms of the solar-energy conversion
technology status, microwave generation and beam transmission,
conversion of microwave power to DC power, and weight and cost
projections. M.V.E.

1972

TL695.A3 1972

A73-24554 The potential of power from space. P. E. Glaser (Arthur D. Little, Inc., Cambridge, Mass.). In: EASCON '72; Electronics and Aerospace Systems Convention, Washington, D.C., October 16-18, 1972. Record. (A73-24551 10-34) New York, Institute of Electrical and Electronics Engineers, Inc., 1972, p. 34-41, 18 refs.

The concept of a satellite solar power station which would have the capability to convert solar energy to microwaves that are beamed to a receiving antenna on earth is presented. Approaches to structural design, flight control, and earth-to-orbit transportation are presented. Criteria for technology assessment and standards for cost comparisons are discussed. It is concluded that the option this concept offers for large-scale use of solar energy could meet a significant portion of future energy demands. M.V.E.

TK
6540
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1972

Institute of Electrical and Electronics Engineers.
1972 IEEE International convention digest.
New York, 1972.

559 p. illus. 28 cm.
"Synopsis of Papers Presented at the 1972
IEEE International Convention March 20-23, 1972,
New York, N. Y."
"IEEE cat. no. 72 CHO 581-9 IEEE."

Solar Energy - An Option for Power
Generation, P. E. Glaser..... 146

A73-22814 A systems engineering overview of the satellite power station. J. Mockovciak, Jr. (Grumman Aerospace Corp., Bethpage, N.Y.). In: Intersociety Energy Conversion Engineering Conference, 7th, San Diego, Calif., September 25-29, 1972, Proceedings. (A73-22751 09-03) Washington, D.C.: American Chemical Society, 1972, p. 712-719, 11 refs.

The utilization of solar energy as a prime power source has been a long-held dream of mankind. With increasing attention focusing on the energy crisis, many new schemes are being proposed involving both space-based and ground-based applications of solar energy. Among these is a proposed concept of a satellite solar power station (SSPS), which collects energy from the sun and transmits it to earth via microwave for conversion to electrical power. Recent systems engineering studies, assessing the technical and economic aspects of the SSPS are presented. These studies indicate that the basic concept is technically feasible, and that it should be examined and compared to other potential energy systems. (Author)

A73-18028 Electrical and isotope power from space for terrestrial use. T. B. Taylor (International Research and Technology Corp., Washington, D.C.). (New York Academy of Sciences, Conference on Planetary and Space Mission Planning, 3rd; New York, N.Y., Oct. 28-30, 1970.) New York Academy of Sciences, Annals, vol. 187, Jan. 25, 1972, p. 420-426.

The concept of an orbital facility for converting solar energy to stored fission energy for use in terrestrial power plants is reviewed in terms of overall system parameters and economics. It is suggested that the concept is worth studying in considerably greater detail. M.V.E.

QC715.P48 1972

A73-14252 The role of solar cell technology in the satellite solar power station. E. L. Ralph and F. Benning (Textron, Inc., Sylmar, Calif.). In: Photovoltaic Specialists Conference, 9th, Silver Spring, Md., May 2-4, 1972, Record. (A73-14203 03-03) New York, Institute of Electrical and Electronics Engineers, Inc., 1972, p. 370-381, 23 refs.

A preliminary study has been completed that has evaluated the feasibility of utilizing large silicon solar cell arrays in the satellite solar power station. An array configuration design was described that utilized ultra-lightweight blankets of solar cells in conjunction with concentrating mirrors. The 1985 projection resulted in a solar cell conversion efficiency of 19.7%, an array blanket output of 430 watts per pound and a blanket cost of \$570 per kilowatt. After concentration to a factor of three and allowing for bussing, radiation losses and transmission to earth, the solar cell array performance was calculated to be as low as 2.6 pounds per kilowatt and \$610 per kilowatt generated on the earth's surface. (Author)

"Power in the Year 2001 Part 3--Solar Power"

The conjunction of several events--the space program, an looming fossil-fuel depletion, degrading environment, an chronic power shortages--is slowly turning man's eyes toward the sun as the ultimate answer to our energy problems. Unlimited power via solar energy gathered and focused earthward by satellites, may yet prove to be the greatest tangible benefit from the space program.

Mechanical Engineering: Nov. 1971 pp. 33-36.

564

1971

A72-11770 Concept for a satellite solar power system. P. E. Glaser (Arthur D. Little, Inc., Cambridge, Mass.). *Chem Tech*, Oct. 1971, p. 606-614. 35 refs.

Description of a concept for a satellite solar power station that involves collection of solar energy conversion to electrical power, and generation and transmission of microwaves. The microwave power, beamed from the satellite to an earth antenna, is converted into electrical power to be distributed through conventional power distribution networks. The technology required for such a satellite solar power station is explored, including conversion of solar energy to electrical power with photovoltaic solar cells, transmission of electrical power over superconducting lines to microwave generators, generation transmission and interception of microwaves, guidance and control of the satellite, and conversion of microwave power to dc power. Consideration is given to the payloads to be placed into orbit, orbit location, satellite station assembly methods, microwave beam interactions with the atmosphere, satellite and earth installation dimensions, and ultimately cost projections. A.B.K.

A72-18625 # Power without pollution. P. E. Glaser (Arthur D. Little, Inc., Cambridge, Mass.). In: Space for mankind's benefit: Proceedings of the First International Space Congress, Huntsville, Ala., November 15-19, 1971. Preliminary Volume. (A72-18609 06-30) Huntsville, Ala., Huntsville Association of Technical Societies, 1971, p. 40-1 to 40-16. 25 refs.

Methods of conversion of solar energy to power are discussed as a possible source of power without pollution. The topics include N/P silicon solar cells, solar power transmission techniques, guidance and control of solar cell systems, cooling equipment, and weight and cost projections for satellite solar power stations. V.Z.

Technology utilization ideas for the 70's and beyond. Edited by F. W. Forbes [and] P. Dergarabedian. Tarzana, Calif., AAS Publications Office [1971] xiv, 315 p. illus. 25 cm. (AAS science and technology series, v. 26)
An American Astronautical Society publication.
Proceedings of a special AAS/AIAA technical event, held October 30, 1970 at Winrock, Arkansas at the invitation of Governor Winthrop Rockefeller.

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A73-18028 Electrical and isotope power from space for terrestrial use. T. B. Taylor (International Research and Technology Corp., Washington, D.C.). (New York Academy of Sciences, Conference on Planetary and Space Mission Planning, 3rd, New York, N.Y., Oct. 28-30, 1970.) *New York Academy of Sciences, Annals*, vol. 187, Jan. 25, 1972, p. 420-426.

The concept of an orbital facility for converting solar energy to stored fission energy for use in terrestrial power plants is reviewed in terms of overall system parameters and economics. It is suggested that the concept is worth studying in considerably greater detail.

M.V.E.

Glaser, P. E., "Satellite Solar Power Station", *Solar Energy*, V. 12, p. 353, 1969.

P. E. Glaser, "Power from the Sun: Its Future", *Science*, Vol. 162, 22 Nov. 1968, pp. 857-861.

Power from space - Technology transfer for human survival. Peter E. Glaser.

H. WIND

Bibliography: T. Baumeister (ed.), *Standard Handbook for Mechanical Engineers*, 7th ed., 1967; E. N. Fales, A new propeller-type windmill, *ASME Trans.*, 50(6):15, 1928; H. Glauert, Windmills and fans, in W. F. Durand (ed.), *Aerodynamic Theory*, vol. 4, 1935; E. W. Golding, *Generation of Electricity by Wind Power*, 1955; E. W. Golding, *Windmills for Water Lifting and the Generation of Electricity on the Farm*, United Nations FAO Informal Working Bull. no. 17, 1961; E. W. Golding and P. E. Montegnon, *Development of a 100 KW Wind Power Plant in the United Kingdom*, 1960; P. Putnam, *Power from the Wind*, 1948.

from: *Encyclopedia of Science & Technology*
article on "Wind power"

POWER FROM THE WIND.

S. Walters.

Mech. Engineering, Apr. 1974, p. 55.

Langley Res. Center vertical-axis windmill.

NASA SPURS WIND GENERATOR TECHNOLOGY.

W.A. Shumann.

Aviation Wk & Space Tech., Apr. 1, 1974, p. 41.

Component fabrication has begun for an experimental 100-kw wind turbine generator. It is the first hardware in a five year program of NASA and Nat. Science Foundation to study practical and economical wind energy conversion systems.

BIBLIOGRAPHY:—P. Linperch, *Architectura Mechanica of Moeder-Rock* (1727); M. Jousse, *L'Art de Charpenterie*, 2nd ed. (1702); J. Smcaton, *An Experimental Enquiry Concerning the Natural Powers of Wind and Water* . . . (1794); A. R. Wolf, *The Windmill as a Prime Mover* (1885); R. Bennett and J. Elton, *History of Corn Milling*, vol. ii (1898); Newcomen Society, *Transactions* (1922-) ; A. Ronse, *De Windmolens* (1934); R. Walles, *The English Windmill* (1954); UNESCO, *Technical Reports* (1953-) ; Electrical Research Association, *Technical Reports* (1954-) ; E. W. Golding, *The Generation of Electricity by Wind Power* (1955); Prinsen Molen Committee, *Research Inspired by the Dutch Windmills* (1958).

from *Encyclopedia Britannica*
article on "windmills".

TILTING AT THE ENERGY CRISIS: A WINDMILL ON YOUR ROOF? F.E. Bryson.

Machine Design, Jan. 10, 1974, p. 20-25.

A number of people are erecting small wind-driven generators on hill tops and roofs. Even Uncle Sam is getting in the act. Wind generators are expensive, but they only cost money.

TAKING POWER OFF THE WIND.

Dr. Arthur Bruckner.

New Scientist, Mar. 28, 1974, p. 812-14.

Britain is well suited for generating electrical power from the wind. Even with a 25 per cent load factor, aerogenerators coupled with a pumped storage scheme would be economically feasible today.

WIND TURBINE GENERATOR. Carter, F. H. US Pat-
ent 3,793,530. 19 Feb 1974. Filed date 19 Apr 1972. 6p.

An electric energy generator is described that is driven by a wind-actuated turbine rotor rotatably supported on a vertically disposed sleeve telescoped over and journaled on a rigid upright supporting post. The rotor includes a plurality of vertically disposed louvers capable of independent pivotal movement about a vertical axis at the inner edge thereof for orientation in radial relation to the rotational axis of the rotor or substantially tangential so that wind will effectively drive the rotor. The rotor is also provided with lift wings on the upper surface thereof that may include stabilizers and shock absorbers fastened to the edge of the wings and the outer edge of the louver support to support part of the load as the rotor whirls in the air providing a floating power device. A wing assembly, which may be hollow and filled with helium gas to reduce the load, is supported on the sleeve above the rotor and includes propeller assemblies mounted thereon to operate the rotor during periods of no wind or only a very slight wind. Governor control means is provided for selectively latching the louvers in tangential relation to the path of movement thereof to prevent the rotor from over-speeding during periods of high wind. Gear assemblies are provided for rotating generators to provide an electrical output that can be used for various purposes thereby utilizing the wind power to produce electrical energy that can be used for various purposes. (auth)

N74-21680*// Kanner (Leo) Associates, Redwood City, Calif.
THIS IS HOW YOU CAN HEAT YOUR HOME WITH A LITTLE
WINDMILL
Washington NASA Apr. 1974 13 p Info Trend. into ENGLISH
from Nv Teknisk (Sweden), no. 3, Jan. 1974 p 8-9

(Contract NASw-2481)
(NASA-TT-F-15518) Avail: NTIS HC \$4.00 CSCL 10A
For many years, small windmills with generators and storage batteries have been available for supplying electricity to remote locations; but storage batteries are so expensive, that this type of electrical supply is normally unrealistic. A better way of utilizing wind power in a smaller installation is to let the electrical current take care of home heating via a heat accumulator, which has low maintenance cost and simple electrical equipment. One such installation is described in this article, and figures on its economic feasibility are provided. Author

Solar Energy and Wind Power. A Bibliography with Abstracts.
Edward J. Lehmann, and Axel C. Ringe.
National Technical Information Service, Springfield, Va. Jul 74. 162p NTIS-WIN-74-049
COM-74-11103/0WE PC\$20.00/MF\$20.00

The bibliography contains 154 selected abstracts of research reports retrieved using the NTIS on-line search system--NTISearch. The report is divided into two sections. The section on solar energy contains 100 abstracts dealing with solar heating for buildings, solar electric power generation, solar cells for terrestrial use, solar energy as a national resource, and solar stoves. The following 54 abstracts concerning wind power cover such topics as its future, conversion systems, energy storage, propeller design, and its uses. Many of these reports on wind power are recent NASA translations of European and Russian research conducted from 1934 to 1959.

S-451

WIND POWER: HOW NEW TECHNOLOGY IS HARNESSING AN
AGE-OLD ENERGY SOURCE.
E.F. Lindsley.
Popular Science, July 1974, p.54-59,124,125.

Popular Science studies the real odds for and
against this nonpolluting, inexhaustible power
source in our fuel-short world.

N74-21680*// Kanner (Leo) Associates, Redwood City, Calif.
REPORT ON RESULTS ACHIEVED WITH SEAS EXPERIMENT-
TAL MILL
J. Jul. Washington NASA Apr. 1974 18 p Trend. into
ENGLISH from Elektrotekniker (Copenhagen) p 5-12
(Contract NASw-2481)
(NASA-TT-F-15515) Avail: NTIS HC \$4.00 CSCL 10A

The SEAS experimental windmill was built in order to attempt operation of a three-phase alternating current generator with a wind turbine as drive power in conjunction with existing ac installations. Testing in natural wind was carried out on the wing shapes that have proved in windtunnel tests to be the most feasible. Investigations were made on how much power can be achieved per unit area within the periphery of the wingtips (= wingspread area). Annual production that can be achieved per unit of wingspread area was determined. The following requirements were worked out experimentally: (1) the most favorable wingtip velocity; regulation arrangement of the wing; (3) the necessary automatic apparatus. Finally, the measured effect of the wind turbine's axle in the wind direction was measured. Author

WINDMILLS: THE RESURRECTION OF AN ANCIENT ENERGY
TECHNOLOGY.

Nicholas Wade.
Science, v.184, June 7, 1974, p.1055-1058.

The windmill seems fair set to make a comeback from the trash heap of technical history. Once a desirable symbol of archaic technology, the environmental reawakening and the sudden wane of the cheap energy era have left the windmill looking more like the feasible alternative power source that its enthusiasts claim it to be.

Energy from the Ocean: An Appraisal.

Owen M. Griffin.

Naval Research Lab Washington D.C. May 74, 47p NRL-

MR-2803

AD-779 877/0WE PC33.25/MFS1.45

The oceans and their environment have long been envisioned as renewable sources of energy. It is the purpose of this report to assess the feasibility of drawing on the sea for power and to determine the extent to which the oceans are likely to serve future energy needs. A review is made of proposed U.S. funding levels for the research and development of renewable energy sources during the years 1975 - 1979, and a study is made of the technical and environmental acceptability status of tidal, wind, and sea thermal power generation systems. The estimated costs of these environmental power sources are compared with the prevailing power costs for nuclear and coal plants. On the basis of these comparisons, recommendations are made for a program of research and development, culminating in the construction of prototype plants, for wind and sea thermal power plants. Tidal power generation is found to be technically feasible but economically uninviting at present.

(Author)

N74-17789*# Scientific Translation Service, Santa Barbara, Calif.
THE dc GENERATORS FOR UTILIZING WIND POWER
 Antonio Cernier Washington NASA Mar. 1974 26 p refs
 Transl. into ENGLISH from Elettrotecnica (Milan), v. 36, 10-25 Aug. p 376-383
 (Contract NASw-2483)

NTIS HC \$4.50 CSCL 10A
 Theoretical considerations are explained and experimental findings pertaining to the possibility of utilizing wind power with electromechanical units comprising various types of direct current machines.
 Author

BACK TO THE WINDMILL TO GENERATE POWER.
 Business Week, May 11, 1974, p.140,142.

If any aspect of the energy shortage is considered humorous, it is the idea of erecting hundreds of giant windmills across the landscape to do their age-old job of converting the wind into power. But to a growing number of people, windmills are not such an absurd idea after all. Companies are now spending their own money to develop a new generation of windmills that will come to market as early as this year.

THE HYDROGEN ECONOMY MIAMI ENERGY (THEME) CONFERENCE.

Presented by The School of Engineering & Environmental Design, Univ. Miami, Coral Gables, Florida.
 Sponsored by The National Science Foundation, Defense Advanced Research Projects Agency, and The School of Continuing Studies, Univ. of Miami.
 Miami Beach, Florida, Mar.18-20,1974.

THE EFFECT OF ATMOSPHERIC TURBULENCE ON WINDMILL PERFORMANCE

T. E. Base, The University of Western Ontario, London, Ontario, Canada

A MODEL FOR THE ECONOMIC EVALUATION OF WINDPOWER SYSTEMS.

I.G. Dambolena and Assoc., Dept. Industrial Engineering and Operations Res., Univ. Mass., Amherst, Mass. 01002.

Reported to Operations Research Soc. Amer.

1973

N74-18706*# Kerner (Loo) Associates, Redwood City, Calif.
ANALYSIS OF THE POSSIBLE USE OF WIND POWER IN SWEDEN. PART 1: WIND POWER RESOURCES, THEORY OF WIND-POWER MACHINES, PRELIMINARY MODEL 1 AND 10 MW WIND GENERATORS

Bengt Soederberg Washington NASA Apr. 1974 55 p refs
 Transl. into ENGLISH of "Utredning om Vindkraftens Moejligheter i Sverige. Etapp 1: Vindkraftresurser - Teori foer Vindkraftmaskiner - Preliminara Vindgeneratormodeller 1 och 10 MW". Swed. Board for Tech. Develop., report. 18 Dec. 1973 44 p

(Contract NASw-2481)
 (NASA-TT-F-15441) Avail: NTIS HC \$5.75 CSCL 10A

Aspects are discussed that must be considered in respect to the possible use of wind power in Sweden, such as availability and nature of wind resources, cost of this type of energy, etc. The basic theory of calculating the power of wind-power machine are presented with tables and diagrams. Data for several large wind-power machines constructed in the U.S.A., Great Britain, etc are given. The conclusion is reached that the use of wind power in Sweden is not feasible, primarily because of its high cost per kWh.
 Author

1973

Amer. Geophys. Union, 54th Annual Meeting, Apr.16-20, 1973, Wash., D.C.

U7 (limited Paper; 30 min)
 William E. Heronemus
 Dept. of Civil Engineering
 Univ. of Mass., Amherst
 Mass. 01002

CN-140,244

Energy: Windpower in the 1970's. The flux of kinetic energy in the winds averages 8x10³ kilowatts over the northern hemisphere. Windmills on practical towers can reach much of it. Free stream momentum machines can extract as much as 5% of the W2 product from a swept area. A 175 foot diameter windmill has operated; a 225 foot diameter machine rated 7.4 megawatts has been designed. The W.M.O. and many national windpower bureaus advanced windpower as significant. Results to 1955 were usually uneconomic compared against fossil fueled heat engine systems. Starting about 1955 the IAEA promises to all nations of very cheap nuclear power scuttled most meaningful windpower development. Demonstrated costs and reliability of reactor plant after 20 years' unlimited investment in nuclear technology now show that self-contained windpower systems can compete. The storage subsystem necessary to accommodate variable winds also provides excellent accommodation of typical electricity demand curves. Windpower systems lend themselves to the all-hydrogen economy, undergrounded transmission, and freedom from air and water pollution.

A74-27772 * # Status of wind-energy conversion. R. L. Thomas and J. M. Savino (NASA, Lewis Research Center, Cleveland, Ohio). *National Science Foundation, RANN Symposium, Washington, D.C., Nov. 18-20, 1973, Paper, 8 p.*

The utilization of wind energy is technically feasible as evidenced by the many past demonstrations of wind generators. The cost of energy from the wind has been high compared to fossil fuel systems. A sustained development effort is needed to obtain economical systems. The variability of the wind makes it an unreliable source on a short-term basis. However, the effects of this variability can be reduced by storage systems or connecting wind generators to fossil fuel systems, hydroelectric systems, or dispersing them throughout a large grid network. The NSF and NASA-Lewis Research Center have sponsored programs for the utilization of wind energy.

F.R.L.

S-438

WIND POWER. J. Collins.

Library of Congress-LC Science Tracer. Sept. 1973.

Scope: The history and current status of windmills as a power source. Inexhaustible and pollution-free, wind power could produce prodigious amounts of energy if trapped on a large scale.

available without charge as
"TB 73-17," from Reference
Section, Science and Technology
Division, Library of Congress,
Wash., D.C. 20540.

WINDMILLS

J. McCaull.

Environment, v.15, no.1, Jan./Feb. 1973, p.6-17.

Trapped on a large scale, wind power theoretically could produce prodigious amounts of electricity.

CM-140.392

1973
THE FEASIBILITY OF WIND-POWER UTILIZATION IN THE
WISCONSIN ENERGY MARKET. William E. Haronemus,
(Mass.U.). (Prepared for Wisconsin State Senator
Douglas LaFollette). Sept. 1973. 45p.

(Massachusetts U.)

Power sources, Wind
Electricity

Staff Report on Wind Power.

Federal Power Commission, Washington, D.C. Bureau of
Power. Sep 73. 13p

PB-231 955/6WE PCS3.00/MF\$1.45

The ten-page pamphlet states that while there is a genuine interest on the part of all electric utilities today in economical and non-polluting sources of electric power, the practical potential for wind-power devices is at present limited, and reasonable solutions for space requirements and land use problems have not yet been developed.

N74-19706 # National Aeronautics and Space Administration.
Lewis Research Center, Cleveland, Ohio.

STATUS OF WIND-ENERGY CONVERSION

Robert L. Thomas and Joseph M. Savino 1973 9 p refs
Presented at the RANN Symp., Washington, D. C., 18-20 Nov.

1973; sponsored by NSF

(NASA-TM-X-71523; E-7912) Avail: NTIS HC \$4.00 CSCL
10A

The utilization of wind energy is technically feasible as evidenced by the many past demonstrations of wind generators. The cost of energy from the wind has been high compared to fossil fuel systems; a sustained development effort is needed to obtain economical systems. The variability of the wind makes it an unreliable source on a short term basis. However, the effects of this variability can be reduced by storage systems or connecting wind generators to: (1) fossil fuel systems; (2) hydroelectric systems; or (3) dispersing them throughout a large grid network. Wind energy appears to have the potential to meet a significant amount of our energy needs.

Author

N74-16757* # National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
WIND ENERGY CONVERSION SYSTEMS
 Joseph M. Savino, ed. Dec. 1973 270 p. refs Workshop Proc. held at Washington, D. C., 11-13 Jun. 1973 (Grant NSF AG-4465)
 (NASA-TM-X-69786; NSF/RA/W-73-006) Avail: NTIS HC \$15.50 CSDL 10B
 Economic feasibilities and energy conversion efficiencies are considered for various alternative energy sources that utilize wind forces. For individual titles, see N74-16758 through N74-16759.

N74-16758* Allis-Chalmers Mfg. Co., York, Pa.
SMITH-PUTNAM WIND TURBINE EXPERIMENT
 Beauchamp E. Smith In NASA. Lewis Res. Center Wind Energy Conversion Systems Dec. 1973 p 5-7 (For availability see N74-16757 08-03)
 CSDL 10B

A brief outline of the many problems encountered during testing of a wind turbine generator prototype unit is given. Its feasibility was demonstrated by the generation of electricity in commercial quantities with delivery to a utility transmission network. The experiment was terminated after blade failure occurred.
 G.G.

N74-16759* Allis-Chalmers Mfg. Co., York, Pa.
MOTION PICTURE HISTORY OF THE ERECTION AND OPERATION OF THE SMITH-PUTNAM WIND GENERATOR
 Carl Wilcox In NASA. Lewis Res. Center Wind Energy Conversion Systems Dec. 1973 p 8-10 (For availability see N74-16757 08-03)
 CSDL 10B

A color movie presentation is discussed that presents the various stages in assembling the major subsystems of a synchronous wind generator, such as installing the rotor blades and the rotating platform at the top of the tower. In addition scenes are shown of the wind generator in operation. Author

N74-16760* Federal Power Commission, Washington, D.C.
PERCY THOMAS WIND GENERATOR DESIGNS
 Charles W. Lines In NASA. Lewis Res. Center Wind Energy Conversion Systems Dec. 1973 p 11-18 (For availability see N74-16757 08-03)
 CSDL 10B

The technical and economic feasibilities of constructing a windpowered generator with a capacity of 2,000 to 4,000 kilowatt are considered. Possible benefits of an integrated wind generating electric energy source in an electric utility network are elaborated. Applications of a windpowered waterpump, including its use as a pumping source for hydroelectric pump storage operations, are also mentioned. It is concluded that the greatest potential of the wind generator is to generate heat directly and not conversion to electricity and then to heat.
 G.G.

N74-16761* Stuttgart Univ. (West Germany).
PAST DEVELOPMENTS OF LARGE WIND GENERATORS IN EUROPE
 Ulrich Hutter In NASA. Lewis Res. Center Wind Energy Conversion Systems Dec. 1973 p 19-22 (For availability see N74-16757 08-03)
 CSDL 10B

Physical size, maximum power output, and other characteristics of various windpower systems are shown in picture form.
 G.G.

N74-16762* Tompkin (Joseph), Salem, Ore.
INTRODUCTION TO VOIGT'S WIND POWER PLANT
 Joseph Tompkin In NASA. Lewis Res. Center Wind Energy Conversion Systems Dec. 1973 p 23-26 (For availability see N74-16757 08-03)
 CSDL 10B

The design and operation of a 100 kilowatt wind driven generator are reported. Its high speed three-bladed turbine operates at a height of 50 meters. Blades are rigidly connected to the hub and turbine revolutions change linearly with wind velocity, maintaining a constant speed ratio of blade tip velocity to wind velocity over the full predetermined wind range. Three generators installed in the gondola generate either 60 or ac current. Based on local wind conditions, the device has a maximum output of 720 kilowatts at a wind velocity of 16 meters per second. Total electrical capacity is 750 kilowatts, and power output per year is 2,135,000 kilowatt/hours.
 G.G.

N74-16763* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
WHERE THERE IS A WIND, THERE IS A WAY
 Charles A. Mosher. In *its* Wind Energy Conversion Systems Dec. 1973 p 27-32 (For availability see N74-16757 08-03)
 CSCL 108

A shift in USA energy policy from oil or natural gases to thermonuclear fission and solar energy is predicted. A massive diversified energy research and development effort to productively harness the energy in the winds is outlined to develop commercially feasible wind energy conversion systems - considered a form of solar energy - in the near future.
 G.G.

N74-16764* West Texas State Univ., Canyon.
NEED FOR A REGIONAL WIND SURVEY
 Vaughn Nelson and Earl Gilmore (Amarillo Coll.) In NASA. Lewis Res. Center Wind Energy Conversion Systems Dec. 1973 p 33-40 (For availability see N74-16757 08-03)
 CSCL 108

Accurate measurements for the purpose of estimating wind energies are proposed in those regions of the USA where the greatest potentials exist. Preliminary wind characteristic calculations from weather station data are provided for the Southern Great Plains region; wind energies from 153 to 212 kW-hr/ft squared-per year for 1970 to 1972 are determined. It is concluded that a wind energy survey based on data compiled from weather service stations is feasible for determining the energy potential of a windpowered integrated energy network.
 G.G.

N74-16765* Oklahoma Univ., Norman.
WIND POWER DEMONSTRATION AND SITING PROB-LEMS
 Karl H. Bergey In NASA. Lewis Res. Center Wind Energy Conversion Systems Dec. 1973 p 41-45 refs (For availability see N74-16757 08-03)
 CSCL 108

Technical and economic feasibility studies on a small windmill to provide overnight charging for an electrically driven car are reported. The auxiliary generator provides power for heating and cooling the vehicle which runs for 25 miles on battery power alone, and for 50 miles with the onboard charger operating. The blades for this windmill have a diameter of 12 feet and are coupled through to a conventional automobile alternator so that they are able to completely recharge car batteries in 8 hours. Optimization of a windmill/storage system requires detailed wind velocity information which permits rational siting of wind power system stations.
 G.G.

N74-16766* Alaska Univ., Fairbanks.
SURFACE WIND CHARACTERISTICS OF SOME ALEUTIAN ISLANDS
 Tunia Wentink, Jr. In NASA. Lewis Res. Center Wind Energy Conversion Systems Dec. 1973 p 46-52 refs (For availability see N74-16757 08-03)
 CSCL 04B

The wind power potential of Alaska is assessed in order to determine promising windpower sites for construction of wind machines and for shipment of wind derived energy. Analyses of near surface wind data from promising Aleutian sites accessible by ocean transport indicate probable velocity regimes and also present deficiencies in available data. It is shown that winds of some degree of power generation are available 77 percent of the time in the Aleutians with peak velocities depending on location.
 G.G.

N74-16767* Oregon State Univ., Corvallis.
WIND POWER RESEARCH AT OREGON STATE UNIVERSITY
 E. Wendell Hewson In NASA. Lewis Res. Center Wind Energy Conversion Systems Dec. 1973 p 53-61 refs (For availability see N74-16757 08-03)
 CSCL 10B

There have been two primary thrusts of the research effort to date, along with several supplementary ones. One primary area has been an investigation of the wind fields along coastal areas of the Pacific Northwest, not only at the shoreline but also for a number of miles inland and offshore as well. Estimates have been made of the influence of the wind turbulence as measured at coastal sites in modifying the predicted dependence of power generated on the cube of the wind speed. Wind flow patterns in the Columbia River valley have also been studied. The second primary thrust has been to substantially modify and improve an existing wind tunnel to permit the build up of a boundary layer in which various model studies will be conducted. One of the secondary studies involved estimating the cost of building an aerogenerator.
 Author

N74-16768* Electrical Research Association, Surrey (England).
WIND DATA FOR WIND DRIVEN PLANT
 Arthur H. Stodhart In NASA. Lewis Res. Center Wind Energy Conversion Systems Dec. 1973 p 62-69 (For availability see N74-16757 08-03)
 CSCL 04B

Simple, averaged wind velocity data provide information on energy availability, facilitate generator site selection and enable appropriate operating ranges to be established for windpowered plants. They also provide a basis for the prediction of extreme wind speeds.
 Author

**N74-16769* Princeton Univ., N.J.
AN INTRODUCTION TO THE PRINCETON SAILWING
WINDMILL**

T. E. Sweeney and W. B. Nixon / In NASA. Lewis Res. Center
Wind Energy Conversion Systems Dec. 1973 p 70-72 refs
(For availability see N74-16757 08-03)
CSCL 108

Specifically discussed is the sailwing windmill. The aerodynamic characteristics of the sailwing itself are presented in condensed form and its natural application to the wind machine is discussed. Past and present sailwing windmill configurations are shown and their relative merits are compared. A section on a future promising configuration is presented and its compatibility to advanced technology electrical machinery is briefly discussed. Also included is a short bibliography.
Author

**N74-16770* Windworks, Inc., Mukwanago, Wis.
THE USE OF PAPER HONEYCOMB FOR PROTOTYPE
BLADE CONSTRUCTION FOR SMALL TO MEDIUM-SIZED
WIND DRIVEN GENERATORS**
G18

Hans Meyer / In NASA. Lewis Res. Center Wind Energy
Conversion Systems Dec. 1973 p 73-74 (For availability see
N74-16757 08-03)
CSCL 110

Paper honeycomb is used for the construction of conventional, propeller-type, windmill blades. Using fairly simple techniques and conventional power tools, it is possible to shape both simple foils and more complex foils with or without tapered plan forms and with or without varying profiles. A block of honeycomb, in its compressed form, is mounted on a wedge and run through a bandsaw with the table at an appropriate tilt angle. It is the combination of the wedge angle and the table angle that gives the tapered planform and profile shape. Next the honeycomb is expanded on the shaft and jugged to give the desired angles of attack. With the honeycomb fixed in position, the blade is covered with a fine weave fiberglass cloth. Any surface quality can then be achieved with filling and sanding.
Author

**N74-16771* New Alchemy Inst., Woods Hole, Mass.
THE SAIL WING WINDMILL AND ITS ADAPTATION FOR
USE IN RURAL INDIA**

Marcus M. Sherman / In NASA. Lewis Res. Center Wind
Energy Conversion Systems Dec. 1973 p 75-79 refs (For
availability see N74-16757 08-03)
CSCL 108

An 8 meter-diameter prototype sail wing windmill is reported that uses a one meter-diameter bullock cartwheel to which three bamboo poles are latched in a triangular pattern with overlapping ends, to form the airframe for cloth sails. This device lifts 300 pounds to a height of 20 feet in one minute in a 10 mph wind.
G.G.

**N74-16772* Army Air Mobility Research and Development
Lab., Moffett Field, Calif.
ROTOR DYNAMIC CONSIDERATIONS FOR LARGE WIND
POWER GENERATOR SYSTEMS**

Robert A. Ormiston / In NASA. Lewis Res. Center Wind Energy
Conversion Systems Dec. 1973 p 80-88 ref (For availability
see N74-16757 08-03)
CSCL 108

Successful large, reliable, low maintenance wind turbines must be designed with full consideration for minimizing dynamic response to aerodynamic, inertial, and gravitational forces. Much of existing helicopter rotor technology is applicable to this problem. Compared with helicopter rotors, large wind turbines are likely to be relatively less flexible with higher dimensionless natural frequencies. For very large wind turbines, low power output per unit weight and stresses due to gravitational forces are limiting factors. The need to reduce rotor complexity to a minimum favors the use of cantilevered (hingeless) rotor configurations where stresses are relieved by elastic deformations.
Author

**N74-16773* Boeing Vertol Co., Philadelphia, Pa.
THE EFFECT OF AERODYNAMIC PARAMETERS ON
POWER OUTPUT OF WINDMILLS**

W. Wiesner / In NASA. Lewis Res. Center Wind Energy Conversion
Systems Dec. 1973 p 89-95 (For availability see N74-16757
08-03)
CSCL 108

Aerodynamic results for a study on windpower generation are reported. Windmill power output is presented in terms that are commonly used in rotary wing analysis, namely, power output as a function of drag developed by the windmill. Effect of tip speed ratio, solidity, twist, wind angle, blade setting and airfoil characteristics are given.
Author

**N74-16774* Science Applications, Inc., La Jolla, Calif. Advanced
Concepts Div.
VERTICAL AXIS WIND ROTORS: STATUS AND POTENTIAL**

W. Vance / In NASA. Lewis Res. Center Wind Energy Conversion
Systems Dec. 1973 p 98-102 (For availability see N74-16757
08-03)
CSCL 108

The design and application of a vertical axis wind rotor is reported that operates as a two stage turbine wherein the wind impinging on the concave side is circulated through the center of the rotor to the back of the convex side, thus decreasing what might otherwise be a high negative pressure region. Successful applications of this wind rotor to water pumps, ship propulsion, and building ventilators are reported. Also shown is the feasibility of using the energy in ocean waves to drive the rotor. An analysis of the impact of rotor aspect ratio on rotor acceleration shows that the amount of venting between rotor vanes has a very significant effect on rotor speed for a given wind speed.
G.G.

N74-16775* Grumman Aerospace Corp., Bethpage, N.Y. Research Dept.
ADVANTAGES OF THE DIFFUSER-AUGMENTED WIND TURBINE
 R. A. Oman and K. M. Foreman *In* NASA, Lewis Res. Center Wind Energy Conversion Systems Dec. 1973 p 103-106 refs (For availability see N74-16757 08-03)
 CSCI 10B

Performance optimization for a wind turbine is realized by using a shrouded diffuser to produce up to twice the power of unshrouded turbines of the same diameter. The diffuser converts the kinetic energy of the flow downstream of the rotor into a pressure rise and thus makes it possible for the rotor to capture airflow from a free stream tube area that is greater than that from the rotor itself. The flow velocity through the shrouded rotor is 20 to 60 percent greater than the free wind velocity as opposed to 67 percent less for the unshrouded case. The diffuser also makes it possible to accommodate very high wind speeds without the need of variable pitch in the rotor blades. G.G.

N74-16776* California State Univ., San Diego.
BUCKET ROTOR WIND-DRIVEN GENERATOR
 Howard H. Chang and Horace McCracken (Sunwater Co.) *In* NASA, Lewis Res. Center Wind Energy Conversion Systems Dec. 1973 p 107-108 (For availability see N74-16757 08-03)
 CSCI 10B

As compared with the ordinary propeller type rotor, the bucket rotor is limited in rotational speed since the tip rotor speed can never exceed the wind speed. However, it does not present the blade fatigue problem that the ordinary rotor has, and it perhaps causes less sight pollution. The deflector vanes also provide a venturi passage to capture greater wind flow. The bucket rotors can be strung together end-to-end up to thousands of feet long to produce large amounts of power. Author

N74-16777* Wisconsin Univ., Madison.
WIND-POWERED ASYNCHRONOUS AC/DC/AC CONVERTER SYSTEM
 D. K. Reitan *In* NASA, Lewis Res. Center Wind Energy Conversion Systems Dec. 1973 p 109-114 refs (For availability see N74-16757 08-03)
 CSCI 10B

Two asynchronous ac/dc/ac systems are modelled that utilize wind power to drive a variable or constant hertz alternator. The first system employs a high power 60-hertz inverter tie to the large backup supply of the power company to either supplement them from wind energy, storage, or from a combination of both at a preset desired current; rectifier and inverter are identical and operate in either mode depending on the silicon control rectifier firing angle. The second system employs the same rectification but from a 60-hertz alternator arrangement; it provides mainly dc output, some sinusoidal 60-hertz from the wind bus and some high harmonic content 60-hertz from an 800-watt inverter. G.G.

N74-16778* Oklahoma State Univ., Stillwater.
AN ELECTRICAL GENERATOR WITH A VARIABLE SPEED INPUT: CONSTANT FREQUENCY OUTPUT
 H. Jack Allison *In* NASA, Lewis Res. Center Wind Energy Conversion Systems Dec. 1973 p 115-120 (For availability see N74-16757 08-03)
 CSCI 10B

A new type of rotary energy conversion device for obtaining a desired constant frequency output independent of the speed of the prime mover has been developed and tested using the technique of field modulation and solid state alternator output processing. A 10-kilowatt prototype field modulated frequency down converter system was designed, built, and successfully tested. Experimentally obtained performance characteristics are presented. Author

N74-16779* Tompkin (Joseph), Salem, Ore.
VOIGHT VARIABLE SPEED DRIVE
 Joseph Tompkin *In* NASA, Lewis Res. Center Wind Energy Conversion Systems Dec. 1973 p 121-122 (For availability see N74-16757 08-03)
 CSCI 10B

The variable speed drive transmission is mounted within the gondola and connected with the wind turbine blades and the hub. This unit is designed for the production of ac power. The turbine turns by means of the variable speed drive and a set of synchronous three phase generators. This motion is controlled automatically by two wind rosettes in such a way that the wind turbine always opposes the wind direction. The Voight variable speed drive is a mechanical variable positive drive gear transmission. It has an unlimited power and torque transmission, a constant ratio with high degree of accuracy, a speed variation over a wide range, and a nonslip drive. Author

N74-16780* Oklahoma State Univ., Stillwater.
ENERGY STORAGE USING HIGH PRESSURE ELECTROLYSIS AND METHODS FOR RECONVERSION
 William L. Hughes *In* NASA, Lewis Res. Center Wind Energy Conversion Systems Dec. 1973 p 123-129 (For availability see N74-16757 08-03)
 CSCI 10C

Theoretical and experimental studies on high pressure electrolysis producing hydrogen and oxygen for energy storage and reconversion are reported. Moderate temperature, high pressure hydrogen/oxygen fuel cells with nickel electrodes are investigated for effects of pressure, temperature, and membrane porosity. Test results from an aphodid burner turbine generator combination obtained 40 percent kilowatt hours out of the fuel cell divided by kilowatt hours into the electrolyzer. It is concluded that high pressure hydrogenation of organic materials can be used to synthesize hydrocarbons and methanes for making synthetic vehicular fuels. G.G.

N74-16781* General Electric Co., Santa Barbara, Calif.
USE OF HYDROGEN AND HYDROGEN-RICH COMPONENTS AS A MEANS OF STORING AND TRANSPORTING ENERGY

Walter Hausz In NASA, Lewis Res. Center Wind Energy Conversion Systems Dec. 1973 p 130-134 (For availability see N74-16757 08-03)
 CSCL 10C

A one-megawatt wind energy source is assumed that uses half of its output to serve customers as electricity, and stores the other half by conversion to hydrogen, to liquid hydrogen, to stored LH₂, and back to electricity. Energy costs and capital costs of the conversions escalate unit costs to 12.9 cents per kilowatt hour. High conversion costs can be reduced by using Mg₂NiH₄ and FeTiH₂ storage, or by using a 100- or 1000 megawatt system.

G.G.

N74-16782* General Electric Co., Lynn, Mass.
STATUS AND APPLICABILITY OF SOLID POLYMER ELECTROLYTE TECHNOLOGY TO ELECTROLYTIC HYDROGEN AND OXYGEN PRODUCTION

W. A. Titterton In NASA, Lewis Res. Center Wind Energy Conversion Systems Dec. 1973 p 135-136 (For availability see N74-16757 08-03)
 CSCL 10B

The solid polymer electrolyte (SPE) water electrolysis technology is presented as a potential energy conversion method for wind driven generator systems. Electrolysis life and performance data are presented from laboratory sized single cells (7.2 sq in active area) with high cell current density selected (1000 ASF) for normal operation.

Author

N74-16783* Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
SUPERFLYWHEEL ENERGY STORAGE SYSTEM

David W. Rabenhorst In NASA, Lewis Res. Center Wind Energy Conversion Systems Dec. 1973 p 137-145 refs (For availability see N74-16757 08-03)
 CSCL 10B

A windpowered system using the superflywheel configuration for energy storage is considered. Basic elements of superflywheels are thin rods assembled in pregrooved hub lamina so that they fan out in radial orientation. Adjacent layers of hub lamina are assembled 90 degree in rotation to each other so as to form a circular brush configuration. Thus stress concentrations and rod failure are minimized and realistic failure containment for a high performance flywheel is obtained.

G.G.

N74-16784* National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
BATTERIES FOR STORAGE OF WIND-GENERATED ENERGY

Harvey J. Schwartz In its Wind Energy Conversion Systems Dec. 1973 p 146-151 (For availability see N74-16757 08-03)
 CSCL 10C

Cost effectiveness characteristics of conventional-, metal gas-, and high energy alkali metal-batteries for wind generated energy storage are considered. A lead-acid battery with a power density of 20 to 30 watt/hours per pound is good for about 1500 charge-discharge cycles at a cost of about \$80 per kilowatt hour. A zinc-chlorine battery that stores chlorine as solid chlorine hydrate at temperatures below 10 C eliminates the need to handle gaseous chlorine; its raw material cost are low and inexpensive carbon can be used for the chlorine electrode. This system has the best chance to replace lead-acid. Exotic alkali metal batteries are deemed too costly at the present stage of development.

G.G.

N74-16785* InterTechnology Corp., Warrenton, Va.
ENERGY STORAGE BY COMPRESSED AIR

George C. Szego In NASA, Lewis Res. Center Wind Energy Conversion Systems Dec. 1973 p 152-154 (For availability see N74-16757 08-03)
 CSCL 10C

The feasibility of windpower energy storage by compressed air is considered. The system is comprised of a compressor, a motor, and a pump turbine to store air in caverns or aquifers. It is proposed that storage of several days worth of compressed air up to 650 pounds per square inch can be used to push the aquifer up closer to the container dome and thus initiate piston action by simply compressing air more and more. More energy can be put into it by pressure increase or pushing back the water in the aquifer. This storage system concept has reheat flexibility and lowest cost effectiveness.

G.G.

N74-16786* Jacobs Wind Electric Co., Inc., Fort Meyers, Fla.
EXPERIENCE WITH JACOBS WIND-DRIVEN ELECTRIC GENERATING PLANT, 1931 - 1967

Marcellus L. Jacobs In NASA, Lewis Res. Center Wind Energy Conversion Systems Dec. 1973 p 155-158 (For availability see N74-16757 08-03)
 CSCL 10B

Engineering, construction, performance, electric output, and different uses of the wind electric 2500- to 3000-watt plant are outlined. After several years of testing different types of windmills, the three blade aeroplane type of propeller was found to be far superior in power output. By means of a flyball governor operated, variable pitch speed control, the maximum speed of the propeller was accurately and easily controlled, to prevent excessive speeds in high winds and storms. The three blade propeller was found to be necessary to prevent excessive vibration whenever the shift of the wind direction required the plant to change its facing direction on the tower.

Author

N74-16787* McGill Univ., Montreal (Quebec). MacDonald Coll.
REVIEW OF THE WINDPOWER ACTIVITIES AT THE BRACE RESEARCH INSTITUTE
 T. A. Lawand /in NASA. Lewis Res. Center Wind Energy Conversion Systems Dec. 1973 p 159-164 refs (For availability see N74-16757 08-03)
 CSCL 10B

A chronology of windpower studies at the experimental station on Barbados is presented that includes the various development activities on wheeling windmills whose power output is utilized through electrical and electronic systems. A list of institute publications on windpower is included. G.G.

N74-16788* Solar Wind Co. East Holden, Maine.
WIND POWER SYSTEMS FOR INDIVIDUAL APPLICATIONS
 Henry M. Grews /in NASA. Lewis Res. Center Wind Energy Conversion Systems Dec. 1973 p 165-169 (For availability see N74-16757 08-03)
 CSCL 10B

A small windpower system is described which is suitable for electrifying a house. The self-contained unit consists of a two kilowatt wind driven generator, a set of 19 storage batteries, a small dc to ac inverter, and a gasoline generator for use as an emergency backup system in case of prolonged calm periods. Cost effectiveness of the electricity generated by this windmill system comes out to about 15 cents per kilowatt hour - assuming a 10 year life for the batteries and a 20 year life for the other components. Some other small windpower systems are also described, and it is shown that a windpowered generator in the 15- to 25-kilowatt output range coupled to a direct heated water storage system is able to heat a typical New England home. G.G.

N74-16789* Pennwalt Corp., Houston, Tex.
ECONOMIC CONSIDERATIONS OF UTILIZING SMALL WIND GENERATORS
 Robert Dodge /in NASA. Lewis Res. Center Wind Energy Conversion Systems Dec. 1973 p 170-173 (For availability see N74-16757 08-03)
 CSCL 10B

The economic feasibility of small wind generators is compared to that of solar cells, primary batteries, thermoelectric generators, and engine generators. It is shown that small wind generator plants offer an attractive alternative to primary battery systems and constantly running engines to generate power in remote areas. The limitation is an annual average wind velocity of at least 9 to 10 mph. Presently available units are most useful in the average load range of 10 to 1000 watts. G.G.

N74-16790* Hydro-Quebec Inst. for Research, Verannes.
WIND UTILIZATION IN REMOTE REGIONS: AN ECONOMIC STUDY

James H. VanSant /in NASA. Lewis Res. Center Wind Energy Conversion Systems Dec. 1973 p 174-176 (For availability see N74-16757 08-03)
 CSCL 10C

A wind driven generator was considered as a supplement to a diesel group, for the purpose of economizing fuel when wind power is available. A specific location on Hudson's Bay, Povungnituk, was selected. Technical and economic data available for a wind machine of 10-kilowatt nominal capacity and available wind data for that region were used for the study. After subtracting the yearly wind machine costs from savings in fuel costs, a net savings of \$1400 per year is realized. These values are approximate, but are thought to be highly conservative. Author

N74-16791* Montana State Univ., Bozeman.
TECHNICAL FEASIBILITY STUDY FOR THE DEVELOPMENT OF A LARGE CAPACITY WIND POWERED ELECTRICAL GENERATING SYSTEM
 Ralph E. Powe /in NASA. Lewis Res. Center Wind Energy Conversion Systems Dec. 1973 p 177-179 (For availability see N74-16757 08-03)
 CSCL 10C

The engineering feasibility of developing a basic mechanical system necessary for extracting large amounts of power (on the order of 10 to 20 MW) from the wind is considered using the concept of vertical airfoils moving along a closed horizontal track system. Attention is focused on those components necessary for the conversion of wind energy to mechanical energy, although the general characteristics and critical aspects of other components are also considered. The four phases of this program are: (1) Establishment of component specifications and interface requirements for major system components; (2) formulation of alternative sets of conceptual designs for major system components; (3) engineering analysis of various components and systems; and (4) re-examination of basic concept and identification of any desirable follow-up work. Author

N74-16793* Aerowatt Corp., Paris (France).
FRENCH WIND GENERATOR SYSTEMS
 John M. Noel /in NASA. Lewis Res. Center Wind Energy Conversion Systems Dec. 1973 p 188-196 (For availability see N74-16757 08-03)
 CSCL 10B

The experimental design of a wind driven generator with a rated power of 800 kilowatt amperes and capable of being connected to the main electrical network is reported. The rotor is a three bladed propeller; each blade is twisted but the fixed pitch is adjustable. The asynchronous 800-kilowatt ampere generator is driven by the propeller through a gearbox. A dissipating resistor regulates the machine under no-load conditions. The first propeller on the machine lasted 18 months; replacement of the rigid propeller with a flexible structure resulted in breakdown due to flutter effects. Author

N74-16792* Oregon State Univ., Corvallis.
THE OREGON STATE UNIVERSITY WIND STUDIES
Robert E. Wilson / In NASA, Lewis Res. Center Wind Energy
Conversion Systems Dec. 1973 p 180-185 (For availability
see N74-16757 08-03)
CSCL 10C

The economic feasibility of commercial use of wind generated power in selected areas of Oregon is assessed. A number of machines for generating power have been examined. These include the Savonius rotor, translators, conventional wind turbines, the circulation controlled rotor and the vertical axis winged turbine. Of these machines, the conventional wind turbine and the vertical axis winged turbine show the greatest promise on the basis of the power developed per unit of rotor blade area. Attention has been focused on the structural and fatigue analysis of rotors since the economics of rotary winged, wind generated power depends upon low cost, long lifetime rotors. Analysis of energy storage systems and tower design has also been undertaken. An economic means of energy storage has not been found to date. Tower design studies have produced cost estimates that are in general agreement with the cost of the updated Putnam 110-foot tower.

N74-16794* Massachusetts Univ., Amherst.
A PROPOSED NATIONAL WIND POWER R AND D PROGRAM
William Heronemus / In NASA, Lewis Res. Center Wind Energy Conversion Systems Dec. 1973 p 197-203 (For availability see N74-16757 08-03)
CSCL 10B

An offshore wind power system is described that consists of wind driven electrical dc generators mounted on floating towers in offshore waters. The output from the generators supplies underwater electrolyzer stations in which water is converted into hydrogen and oxygen. The hydrogen is piped to shore for conversion to electricity in fuel cell stations. It is estimated that this system can produce 159 x 10 to the ninth power kilowatt-hours per year. It is concluded that solar energy - and that includes wind energy - is the only way out of the US energy dilemma in the not too distant future.

N74-16795* Budgen and Associates, Pointe Claire (Quebec).
A COMMENT ON TOWERS FOR WINDMILLS
Harry P. Budgen / In NASA, Lewis Res. Center Wind Energy Conversion Systems Dec. 1973 p 204-205 (For availability see N74-16757 08-03)
CSCL 10B

Design considerations for windmill tower structures include the effects of normal wind forces on the rotor and on the tower. Circular tubular or masonry towers present a relatively simple aerodynamic solution. Economic factors establish the tubular tower as superior for small and medium sized windmills. Concrete and standard concrete block designs are cheaper than refabricated steel structures that have to be freighted.

N74-16796* Stuttgart Univ. (West Germany).
SOME EXTENSIVE COMMENTS ON OUR EXPERIENCES WITH TOWERS FOR WIND GENERATORS
Ulrich Hutter / In NASA, Lewis Res. Center Wind Energy Conversion Systems Dec. 1973 p 206-207 (For availability see N74-16757 08-03)
CSCL 10B

A wind generator tower must be designed to withstand fatigue forces and gust winds loads. Optimum tower height depends on the energy cost to the customer because an increase in height results in an increase in the cost of the plant. It is suggested that costs are minimum for the shortest tower possible and that the rotor should be as large as possible.

N74-16797* AeroVironment, Inc., Pasadena, Calif.
WIND MACHINES
P. B. S. Lissaman / In NASA, Lewis Res. Center Wind Energy Conversion Systems Dec. 1973 p 208-239 (For availability see N74-16757 08-03)
CSCL 04B

The basic elements of the air/water momentum exchange are described by the environment, the potential, the air and water subsystems, the total system, and the rule. Many of these topics have direct analogues in aerogenerator design. Aspects of optimal sail design and of waveless hulls are briefly outlined. A wind driven vehicle capable of moving directly downwind faster than the wind is reported. The lecture is illustrated with slides and movie clips showing surfing catamarans, land and water versions of the Baeur vehicle, hang gliding, land sailing, and wind surfing.

N74-16798* National Science Foundation, Washington, D.C.
NSF PRESENTATION
Frederick H. Morse / In NASA, Lewis Res. Center Wind Energy Conversion Systems Dec. 1973 p 240-243 (For availability see N74-16757 08-03)
CSCL 10B

Wind energy conversion research is considered in the framework of the national energy problem. Research and development efforts for the practical application of solar energy -- including wind energy -- as alternative energy supplies are assessed in: (1) Heating and cooling of buildings; (2) photovoltaic energy conversion; (3) solar thermal energy conversion; (4) wind energy conversion; (5) ocean thermal energy conversion; (6) photosynthetic production of organic matter; and (7) conversion of organic matter into fuels.

S-439

ATLANTIC RICHFIELD RIDICULES WINDPOWER WHILE OTHERS
MAKE IT WORK. Hon. Mike Gravel.

Congress. Record, May 29, 1973, p.E3518-E3520.

Excerpts from 'I Built a Wind Charger for \$400!' by J. Sencenbaugh are included.

AERO ENGINEERS BUILD BETTER WINDMILLS.
(Canadian and Princeton Univ.)

WINDMILLS - THE CHIMERA OF FREE ELECTRICITY.

New Scientist, 4 Jan. 1973, p.24.

POWER FROM WIND WAVES. A device designed to produce electric power by using energy available in wind waves is described. The power unit consists of two side walls and a series of vertical chambers with open outlets at or near the nodal line. The upper end of each chamber is provided with an intake one-way valve for intake from the intake plenum, and a discharge one-way valve for discharge to the discharge plenum.

Cullen, John F. *Navl Eng* v 77 n 2 Feb 1973 p 14-15.

TRY AND CATCH THE WIND.

Technology Review, May 1973, p.51-52.

N73-21238*4 Linguistic Systems, Inc., Cambridge, Mass.
PROBLEMS CONCERNING AUTOMATIC CONNECTION OF
AN AEROGENERATOR TO A NETWORK
F. Delalande Washington NASA Apr. 1973 14 p ref Tensel.
into ENGLISH from the Algerian Report (French-Language)
(Contract NASw-2482)

(NASA-TT-F-14873) Avail: NTIS HC \$3.00 CSCL 09C
Modifications were made to the 100 kW Andreau-Enfield experimental aerogenerator, supplying a three-phase network, with the results that: (1) connection to the network was automated and rendered almost instantaneous; (2) propeller starting and stopping were automated; and (3) the amplitude of pumping in high wind was reduced by altering the change-of-pitch speed of the propeller. This machine is functioning previously of power oscillations with wind gusts are still being worked on. It is believed that the aerogenerator is suitable for supplying a large network. for small networks three or more smaller machines would have to work in connection to even out power variations. Author

(UCRL-51469) ANALYSIS OF THE WINDS OF SITE
300 AS A SOURCE OF POWER. Archibald, P. B. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 23 Oct 1973. Contract W-7405-eng-48. 17p. Dep. NTIS \$4.00.

Site 300 is a strategically located area lying east of the Lawrence Livermore Laboratory at Livermore, California. The prevalent wind is from the west; its driving force is the pressure gradient between the hot interior valleys and the cool marine air of the Pacific Ocean. Wind measurements indicate that this is a good site for electrical power generation. (auth)

TK 2896. I55 1973

8th Intersociety Energy Conversion
Engineering Conf. Aug 13-16, 1973

Performance Evaluation of Wind Driven Heating Systems - N. GALANIS,
A. DeLISLE.....

1973

N74-16799* National Aeronautics and Space Administration.
Lewis Research Center, Cleveland, Ohio.

NASA PRESENTATION

Ronald L Thomas In its Wind Energy Conversion Systems Dec.
1973 p 244-253 (For availability see N74-16757 08-03)
CSCL 108

The development of a wind energy system is outlined that
supplies reliable energy at a cost competitive with other energy
systems. A government directed industry program with strong
university support is recommended that includes meteorological
studies to estimate wind energy potentials and determines
favorable regions and sites for wind power installations. Key
phases of the overall program are wind energy conversion systems,
meteorological wind studies, energy storage systems, and
environmental impact studies. Performance testing with a
prototype wind energy conversion and storage system is projected
for Fiscal 1977.
G.G.

CH-140,243

1972

**THE UNITED STATES ENERGY CRISIS: SOME PROPOSED
GENUINE SOLUTIONS.** William E. Horonemus, (Massachu-
setts U.). (Presented before a joint meeting of
the local sections of ASME and IEEE, West Spring-
field, Mass., Jan.12,1972). 49p.

Massachusetts U.
American Society of Mechanical
Engineers
Institute of Electrical and
Electronics Engineers, Inc.

Power sources, Wind
Power sources, Ocean
(Ocean Thermal Gradients)

L-1-9-74

N72-74989

WINDMILL GENERATOR FOR THE BUMBLEBEE BUOY.

Brown, D. M.
Scripps Institution of Oceanography, La Jolla,
Calif. Avail.NTIS.

AD-744202 SIO-REF-72-59 N00014-69-A-0200-6006
72/06/01 19 pages.

CH-140,243

1972

POLLUTION-FREE ENERGY FROM OFFSHORE WINDS.
William E. Horonemus, Massachusetts U.
(Presented at the 8th Annual Conference and
Exposition, Marine Technology Society, Washington,
D.C., Sept.11-13,1972). 36p.

Marine Technology Society
Massachusetts U.

Marine Technology Society Conference Sept.11-13,
and Exposition, 8th 1972

Power sources, Wind
Hydrogen
Fuel cells

L-1-9-74

S-412

ELECTRIC POWER FROM WINDMILLS?

S. Kidd and D. Garr
Popular Science, Nov.1972, p.70-72.

Many attempts have been made to tap the wind's
power - all failures. Now a unique blade design
may make windmills serious business.

(Sailing blades)

Power from the offshore winds. W.E. Horonemus (Univ. Masse-
chusetts, Amherst, USA).
8th Annual Conference and Exposition on Applications of Marine Technology
to Human Needs, Preprints, Washington DC, USA, 11-13 Sept. 1972
(Washington DC, USA: Marine Technol. Soc. 1972), p.433-66
It has been estimated that the total rate of conversion between available potential
energy and kinetic energy in the atmosphere of the whole Northern Hemisphere
in winter is about 10¹⁴ kilowatts reducing to about sixty percent of that value in
summer. The Westerlies are of particular significance to the United States
because in a sense they are a bonus of solar energy. The atmospheric and
oceanic processes which create their energy occur over the adjacent and distant
oceans as well as over the land mass; the result is felt particularly along land-
to-water boundaries. It is suggested that man might once again turn to those
winds and to the ocean currents which they help to sustain to help satisfy his
need for energy. If such energy were used, it would be essentially pollution-free
and would have a neutral effect on global heating. A number of concepts for
Offshore Wind Power Systems are proposed. (19 refs.)

N74-15742*# Kanner (Lao) Associates, Redwood City, Calif.
WIND-POWERED MACHINES.
 Ya. I. Shefter Washington. NASA Jan. 1974. 279 p refs
 Transl. into ENGLISH of the book "Vetroenergeticheskiye
 Agregaty" Moscow, Mashinostroyeniye Press, 1972. 288 p
 (Contract NASw-2481)
 (NASA-TT-F-15149) Avail: NTIS HC \$16.00 CSCL 10A

The basic problems connected with the selection of layouts and calculation of parameters of wind machines, their energy-producing characteristics and technical and economic indices are presented. Methods of optimal matching of wind engines with working machines, calculators for strength, and construction and automation of wind machines are analyzed in detail. A description is given of the setup of domestic and foreign wind installations for various purposes. Basic characteristics of wind as a source of energy, brief information from aerodynamics, the theory of the wind engine and calculation of its aerodynamic characteristics are presented. In conclusion, recommendations are presented for use of wind machines according to zone. The book is intended for engineers, designers and workers of scientific and research institutes connected with creation and utilization of wind machines and for engineers and mechanics in agriculture.

Author

Fink, Donald E.: New Air Foil Design Method Developed.
 Aviation Week and Space Technology, Nov. 1972.

AIRSHIPS & WINDMILLS — POWER IN THE SKY.

New Scientist and Science J., Apr. 8, 1971, p. 90.

A Russian design for a windmill station which will operate off the jet stream.

IEEE REGION 3 CONVENTION, SOUTH-EASTERN 1972, PROCEEDINGS OF THE 18TH ANNUAL SCANNING THE SPECTRUM. In Session V: Applications of Engineering Technology, the following papers were presented. Synthesis of Direct Digital Control Algorithms for Wastewater Treatment Plants. By A.S. Collins, B.E. Gilliland and J.F. Andrews. Noise Abatement Program for Industry. By Charles E. Hickman. Analytical Model for Optical Determination of Respirable Coal Dust Particle Size. By T.F. King, G.W. Hoffman, J.C. Hung and D. Rosenberg. Theory of Electronic PBX Systems - Video Tape Approach. By C.M. Goodson and I.A. Vandergriff. Radio System for Mine Rescue. By Charles K.H. Tsao. Urban Electric Car Design. By Charles C. Flakey and Ronald W. Larson. Technological Adaptations to Aerobically Energy Utilization in the Arabian Peninsula. By Herbert A. Schmitt.

Charles A.L. Gilliland, B.E.; Andrews, J.F.; Hickman,

Charles E. King, T.F. Hoffman, G.W. Hung, J.C. Rosenberg, D. Goodson, C.M. Vandergriff, I.A. Tsao, Charles K.H. Flakey, Charles C. Larson, Ronald W. Larson, Herbert R.A. IEEE Reg 3 Conv, 10th, Annual Proc, Pap. Univ of Tennessee, Knoxville, Apr 10-12 1972 Publ by IEEE (71 CHO 591-8 REG III), New York, 1972.

A72-36301

N74-15748*# Linguistic Systems, Inc., Cambridge, Mass.
METHOD OF CALCULATION OF ANNUAL OVERALL EFFICIENCY OF MODERN WIND-POWER PLANTS
 F. D. Pipes and Washington. NASA Feb. 1974. 13 p refs
 Transl. into ENGLISH from Ingenieur (The Hague), v. 63, no. 47, 23 Nov. 1971. p. W137-W140
 (Contract NASw-2482)

(NASA-TT-F-15310) Avail: NTIS HC \$3.00 CSCL 10B
 A method of calculating the annual overall efficiency of modern wind power plants equipped with asynchronous generators is reported that takes into account the annual velocity duration curve at Den Helder, Holland. A comparison is made between variable pitch windmills and fixed blade windmills equipped with movable flaps. A careful calculation is recommended in view of rather small differences in efficiency for both systems.

Author

N73-33011# Army Foreign Science and Technology Center, Charlottesville, Va.
SOLAR AND WIND POWER TO BE HARNESSSED
 Ya. Shefter, G. Aleksenko, N. Liderenko, S. Iosipyan, and A. Shakhov. 1 Nov. 1972. 6 p. Transl. into ENGLISH from Pravda (Moscow), 11 May 1971. p. 3
 (AD-765783; FSTC-HT-23-922-72) Avail: NTIS CSCL 10/2
 The state-of-the-art of wind and solar power installations are discussed.
 GRA

Proceedings of the United Nations Conference on New Sources of Energy, Rome, Aug. 1971, vol. 7, Wind Power. United Nations

1970

N72-31032# Army Foreign Science and Technology Center, Charlottesville, Va.
 SERIES OF NO-CONTACT SYNCHRONOUS GENERATORS WITH OUTPUTS UP TO 100 KV FOR WIND DRIVEN ELECTRIC UNITS
 L. D. Urusov, V. S. Ryzhkov, L. A. Zilbershtein, and V. K. Volchkov 7 Oct. 1971 12 p refs Transl into ENGLISH from Elektrotehnika (USSR), no. 1, 1970 p 56-58 (AD-742641; FSTC-HT-23-1434-71) Avail: NTIS CSCL 10/2

The need for design of a specialized series of no-contact synchronous generators with outputs up to 100 kv for wind-driven electric units and the basic technical characteristics of the series of generators are discussed.
 Author (GRA)

NOTES ON THE DEVELOPMENT OF THE BRACE AIRSCREW WINDMILL AS A PRIME MOVER.

Brace Inst., McGill Univ.
 Aeronautical Jour., Apr. 1969, p. 333-334.

32-ft diameter cheap power source.

TK 2896. I 55 1969

Wind energy storage and conversion system for use in underdeveloped countries; R. RAMAKUMAR (Oklahoma State Univ, Stillwater), K.A. MCCOLLOM, H.J. ALLISON, W.L. HUGHES; Proc of 4th Intersociety Energy Conversion Eng Conf, Washington, DC, Sept 22-26 1969 paper 690074 p 606-13; The feasibility of fabrication, installation and operation of a wind energy conversion and storage system in a small remote rural community in a developing country is discussed. Details of a preliminary analysis of the economics of the energy package are given and the results are shown to be encouraging. Experimental results obtained from a prototype model are presented and discussed. 17 refs.
 27766

Notes on the development of the Brace airscrew windmill as a prime mover; R.E. CHILCOTT; Aeronautical J v 73 n 700 Apr 1969 p 333-4; A 32 ft diam airscrew windmill, fabricated of fiber-glass reinforced epoxy resin, is used as a prime mover in irrigation and vapor compression distillation applications. The three-blade fixed pitch screw is coupled to a deep-well turbine pump through truck transmission parts. The success of this installation demonstrates the feasibility of using such a system of built readily available parts, for harnessing wind power economically.
 40374

1968

N68-33881# Mississippi State Univ., State College. Dept of Aerophysics and Aerospace Engineering.
 DEVELOPMENT OF AN ENGINE-POWERED LIQUID DISPERSAL SYSTEM FOR AGRICULTURAL AIRCRAFT
 Michael R. Smith, Robert E. Williamson, and A. Jack Garrett Jan. 1968 57 p refs
 (Contract AF-66-WA-1531)
 (FAA-DS-68-3; AD-671891)

The report presents the results of efforts to design a liquid dispersal system for agricultural aircraft which would have low power requirements as compared to standard windmill powered pump systems. The resulting system consisted of a standard spray pump powered from the aircraft engine accessory pad and a spray boom mounted in the wing wake. The maximum power requirement of the final configuration was 12.5 brake horsepower at 100 miles per hour as compared to 52 brake horsepower for the standard system. Significant increases in climb performance and reduction of level flight power requirements were measured. No adverse effects on stall characteristics and control feedback were noted.

Author (TAB)

1969

"A Wind Energy Storage Technique Utilizing a Hydrogen-Oxygen Electrolysis Cell System" by H. Jack Allison, 1968, presented at the Frontiers of Power Technology Conference, Oklahoma State University.

Putting the wind to work

Anon., Engineering, Lond., 205 (3353), 760-761, (23 Nov. 1968). Wind might provide competitive power for water desalination, particularly if reverse osmosis is further developed.

1969

Utilization of Wind Power in Arid Areas of Rajasthan, N.L. KACHHARA. Indian J Power & River Valley Development v 17 n 8 Aug 1967 p 21-6, 30. Estimation of available wind power in Rajasthan shows that it is possible to have outputs of 10, 50, 50 and 100 kw with various rotor diameters; use of wind power for irrigation, corn grinding, fodder cutting and similar jobs. 10 refs.

582

Power supply by wind energy to households and farms at a distance from settlements

Dóry, B., *Energia Atomtech.*, 19, (8), 346-348, (1966). 12% of the population of Hungary lives on farms distant from larger settlements. It is practicable to use low-power windmills for the power supply of isolated houses and farms. A windmill driving a 200-600 W generator with battery will cover the power required by a household and farmyard. The promising results of wind measurements conducted thus far constitute an objective basis for calculations. The establishment of major units is expedient as well as economical; in Hungary the cost of establishing 800 ml of a 35 kV power line is equal to that of a 50 kW windmill. A 50 kW windmill could provide for the water husbandry of 200-230 hectares on a 45 m high slope. The cost of establishing a windmill overcoming a delivery head of 10 m is only one-quarter of the former, its return period being 1-2 years. The utilization of wind energy can be combined with that of farm gas and pneumatic energy storage.

N65-33046# National Aeronautical Lab., Bangalore (India).

A NOTE ON THE FEASIBILITY OF WIND GENERATION OF ELECTRIC POWER FOR COMMUNICATION LINKS IN INDIA

S. P. Venkiteshwaran, K. R. Sivaraman, and C. G. Gupte Feb. 1965 19 p refs
(TN-WP-36-65) CFSTI: HC \$1.00/MF \$0.50

The power requirements of solid-state microwave radio links are very low, and could be adequately met by storage batteries charged by small wind electric generators. This would be possible at sites that are sufficiently windy to operate the generator to give a stable output. Wind electric generators in this range are not commercially available in this country at present. The paper describes a wind electric generator designed in the laboratory for this purpose. The estimates of output in watt-hours using such a generator at five stations in India have also been computed in the paper. Author

N73-29006# Kerner (Leo) Associates, Redwood City, Calif. OPERATING EXPERIENCE OBTAINED WITH A 100 kW WIND POWER PLANT
U. Huettner Washington NASA Aug. 1973 27 p refs Transl. into ENGLISH from Brennstoff-Waerme-Kraft (Duesseldorf), v. 16, 1964 P333-340

(Contract NASw-2481)
(NASA-TT-F-15068) Avail: NTIS HC \$3.50 CSCL 10A

An excerpt is given from the report on experiments and experience associated with the wind power plant and covering design data and those aspects which were decisive in its layout and the type of regulating provisions used, as well as results of the detailed operational tests. The regulating system and the automatic cut-in provisions permit the system to be connected automatically to the public power supply network on the basis of a specific program. The various types of wind conditions considered in designing the power plant are described. Author

N66-19213# National Aeronautical Lab., Bangalore (India). A STUDY OF THE HOURLY WIND SPEEDS AT KODAIKANAL FROM THE POINT OF VIEW OF WIND POWER UTILISATION

M. S. Prakasa Rao and S. R. Radhakrishnan Dec. 1964 24 p ref Revised
(TN-WP-17-62) CFSTI: HC \$1.00/MF \$0.50

The hourly wind speeds at Kodikanal have been used to estimate the energy extractable from the wind. The number of hours of low winds, the spells of such low winds with different durations and the diurnal variation of the wind are discussed. The annual mean wind speed works out to 11 km.p.h. The annual output of a wind electric generator of 30 sq.m swept area and an overall power coefficient of 12 percent works out to 1.553 kWh. The water pumping capacity of a WP-2 type windmill is 55,850 kl (12,310,000 gallons) per annum or 36,500 gallons per day. Author

N68-22060# National Aeronautical Lab., Bangalore (India). UTILISATION OF WIND POWER IN ARID AND SEMI-ARID AREAS IN INDIA

S. P. Venkiteshwaran and K. R. Sivaraman Nov. 1964 23 p refs
(TN-WP-35-64)

The WP-2 type of water pumping windmill is useful in regions of low and moderate wind speeds. The average wind speed at most of the places in Rajasthan during the summer months, which are the windiest, varies from 12 to 18 km per hour and the windmill gives its optimum output in this range of wind speeds. The wind speed data available for five stations in Rajasthan have been analyzed, and the monthly quantities of water that can be pumped by a WP-2 windmill through a height of 10 meters have been worked out for these stations. It is seen that the WP-2 windmill can pump about 15,000 gal of water per day through a height of 10 meters under favorable wind speeds during summer months. The economics of operation of WP-2 windmills at these places has also been studied. At all places studied the water pumped is a maximum during the summer months. A study of the characteristics of wind electric generators of different capacities ranging from 1kW to 25kW in relation to the wind regime in Rajasthan shows that wind electric generators in the range of 2 to 5 kW are comparatively economical. Author

1963

N64-29491 Oklahoma State U., Stillwater
THE BASIC TECHNICAL PROBLEMS ASSOCIATED WITH A
SOLAR TO ELECTRICAL SYSTEM WITH INTERMEDIATE
ENERGY STORAGE
C. M. Summers In its Proc. of a Conf. on Energy Conversion
and Storage p 89-95 (See N64-29484 21-06) Okla. State U.
\$5.00

The five basic groups of components for a proposed pilot-
plant operation, based on solar to electrical energy conver-
sion with intermediate energy storage, are listed. The tech-
nological problems associated with each group include these:
(1) the solar (in this case, wind energy) to electrical energy
transducer; (2) the electrolysis and storage system; (3) the fuel
cell; (4) the solid-state inversion system; and (5) reconversion
components to convert excess electrical energy to a fuel storage
M. P. G.

N65-86413

PERFORMANCE OF THE 6-8 KW ALLGAIER WIND ELECTRIC
GENERATOR AT PORBANDAR.

Rao, D.V.L. and Venkiteshwaran, S. P.
National Aeronautical Lab., Bangalore, India.
TN-WP-33-63 Dec. 1963 32 pages

N64-29486 Oklahoma State U., Stillwater
A QUANTITATIVE EVALUATION OF POWER DENSITY AND
STORAGE CAPACITY FOR SOLAR AND WIND ENERGY
C. M. Summers In its Proc. of a Conf. on Energy Conversion
and Storage p 15-33 (See N64-29484 21-06) Okla. State U.
\$5.00

Increasing efficiencies of fuel cells that convert and re-
convert hydrogen and oxygen fuel and electricity directly makes
the age-old dream of utilizing solar energy more feasible.
Calculations of the annual mean power-density value, of the
efficiency of solar conversion units, and of the storage ca-
pacity required show that this method is not economically feasi-
ble at present. The same calculations made for wind energy
(another form of solar energy) show that wind energy conver-
sion is technically and economically feasible. A comparison of
solar-energy and wind-energy power-density data shows that
in those months when the sunlight is above average, the wind
is below average; therefore, a combination of the two
might be used to produce a more constant output.
M. P. G.

1963
N64-13346 National Aeronautical Lab., Bangalore (India)
A STUDY OF THE HOURLY WIND SPEEDS AT JAIPUR FROM
THE POINT OF VIEW OF WIND POWER UTILIZATION

M. S. Prakasa Rao and S. R. Radhakrishnan Apr. 1963 19 p
refs
(TN-WP-25-63)

Certain characteristics of wind, such as frequency dis-
tribution, spells of low winds, and the diurnal variation are
discussed. The annual energy output of an aerogenerator of
30 m² swept area and an overall power coefficient of 12
percent is estimated at 561 kwh. The annual water pumping
capacity of a direct-acting windmill with the same overall
power coefficient, but with a swept area of 23.6 m² (WP-2-
type windmill), is estimated at about 17,550 kl (3,861,000
gal), i.e., 10,580 gal/day. The annual mean wind speed is
7 km/hr.

Author

N64-13345

National Aeronautical Lab., Bangalore (India)

A STUDY OF HOURLY WIND SPEEDS AT BHOPAL FROM THE POINT OF VIEW OF
WIND POWER UTILIZATION

M. S. Prakasa Rao Apr. 1963 21 p ref

(TN-WP-23-63)

The yearly average wind speed at Bhopal
is 11 km/hr. The annual energy output is 1,370 kwh for a wind
electric generator with an overall power coefficient of 12 per-
cent. The annual water pumping capacity of a WP-2-type wind-
mill is estimated at about 42,000 kl (9,240,000 gal). Author

1/27/64 3

N65-85480

UTILIZATION OF WIND POWER FOR IRRIGATION OF CROPS
IN INDIA WITH SPECIAL REFERENCE TO THE DISTRIBUTION
OF WIND AND RAINFALL.

Sivaraman, K. R. and Venkiteshwaran, S. P.
National Aeronautical Lab., Bangalore, India.

Nov. 1973 18 pages TN-WP-30-63

(Presented at the Symp. on Optimum Requirements
and Utilization of Water for Irrigation of Crops,
Central Board of Irrigation and Power, New Delhi,
Nov. 1963.)

A63-12925 (TL505.C52 1962)

1962/63

International Seminar on Solar and Aeolian Energy
(Proceedings held in Soumion, Greece, Sept.
4-15, 1961). A. G. Spanides, Ed. 621-47
In 8

Methods of assessing the potentialities of wind
power on different scales of utilization,
E.W. Golding. p.152-

A63-14548

Shrouded Aerogenerator Design Study-2, Axisymmetrical Shroud
Performance, A.KOGAN, A.BEGINER, Israel Soc Aeronautical Sci-
ences-Conference on Aviation & Astronautics 5th-Proc 1963 p
49-56. Possibilities of improving efficiency of wind powered gen-
erator were investigated; performance of shroud was tested by
simulating action of turbine rotor by energy dissipating screen;
3 shroud configurations were investigated; each shroud was tested
with 13 screens; experiments revealed dependence of generator
power coefficient on shroud geometry and turbine load factor; dif-
fuser pressure recovery and overall pressure ratio were found to
depend on shroud geometry and screen solidity ratio, and influenced
by deflection angle of shroud; maximum power coefficient and op-
timum load factor were found for each shroud geometry.

Generation of Power from Wind in East Pakistan, A.HOSAIN.
Inst Engrs (Pakistan)-Annual Convention-Tech Papers v 13 Apr
1962 p 1-6. Developments in field of wind power are described,
including wind driven Smith-Putnam turbine rated at 1250 kw con-
structed in 1941 at top of 2000 ft high peak in Vermont, United
States, feeding alternating current synchronously to high-line of
utility system; investigation of possibilities of generating cheap
electricity by utilizing power from wind is recommended; tables
of mean wind speed for 6 stations in East Pakistan and average
speeds of winds 1600 ft above ground in one station are given.

N74-19710# Kanner (Leo) Associates, Redwood City, Calif.
REPORT OF THE WIND POWER COMMITTEE OF 1962
E. Volmer Nielsen Washington NASA Apr 1974 32 p Transl
into ENGLISH of "Uddrag af Vindkraftudvalgets Beretning af
1962". Danish Assoc. of Elec. Supply Undertakings report, 1962
28 p
(Contract NASw-2481)

(NASA-TT-F-15442) Avail: NTIS HC \$4.75 CSCL 108
The Danish Wind Power Committee's experiments with
propeller windmills are described, specifically the 25-m-high
windmill at Gedser. Wind measuring stations were established,
and the wind energy available and optimum locations deter-
mined. A cost comparison was made of electricity from wind
and steam power, and the committee concluded that wind
power plants were economically unfeasible to develop at that
time.
Author

The need for simplicity in the design of windmills
L. Sterne. p.158-

Lay-out optimization fo wind-power plants.

U. Hutter. p.173-

Proposed method of wind energy computation.

S. Papagianakis. p.204-

The aeolian energy in Greece. S. Papagianakis.
p.208-

1959

N74-15766# Kanner (Leo) Associates, Redwood City, Calif.
WIND-POWER SUPPLY FOR THE DECIMETER RANGE
DIRECTIONAL RADIO SITE AT SCHOENEBOURG (EIFEL)
AND THE EXPERIENCE GAINED
G. Rosselet Washington NASA Feb 1974 29 p refs Transl
into ENGLISH from Nachrichtentech. Z (West Germany), v. 12,
Jul. 1959 p 352-380
(Contract NASw-2481)

(NASA-TT-F-15337) Avail: NTIS HC \$3.50 CSCL 10B
The Schoeneburg directional radio station is located far from
public power lines on a hilltop where the average wind velocity
is 5.6 m/sec. The station, as first designed, required 28 kWh/day
of dc power. It uses two Allgaier wind power systems, Dr. Hutter
type WE/G 6, with a nominal output of 6 kW at 9 m/sec and
1 kW at 4.2 m/sec wind velocity mounted on two 10-m high
tubular poles. The dc generators are differentially compounded.
shunt-wound. Lead storage batteries of 110 cells and 216 Ah
are used to stabilize the output and store the energy. A diesel
generator system is available as an emergency system. Tests
show that more than 90% of the power required for the initial
unmodified communications system could probably have been
supplied by the wind power system. The results were completely
positive. Wind power stations are economically advantageous
where it is very expensive to connect to the public power system,
where adequate wind is available and especially when only a
moderate amount of power is required.
Author

Criteria for Design of Windmills for Low to Moderate Wind
Velocities, M.S. EKHROY, R. V. RAJAGOPALAN, C. R. RUPPE,
Sci & India Research v 18A n 8 Aug 1969 p 372-6. Design of
windmills for 6 to 10 mph wind velocities; two pumping water
windmill designs are described; momentum and blade element
theories, general requirements and design variable values; var-
ious blade rotors were studied and theoretical torque and power
values determined; specifications for two windmills suitable
for conditions in India.

CW-81908, pt.2
THE GENERATION OF ELECTRICITY BY WINDMILLS.
(La production d'énergie électrique par
eoliennes). L. Vadot. Jan.-Feb.1959.
(Eng. and Fr. text). Reprint
Houille Blanche, no.1, p.3-22 Jan.-Feb.
(France) 1959

Two fundamental problems of windmill design
are considered; determining the dimensions
of the machine and its output. Economic
and engineering considerations make it
possible to define the most advantageous
characteristics for a windmill. In view of
available wind power in the Atlantic region,
it is of immediate interest to use wind
generators.

CW-81908, pt.1
THE GENERATION OF ELECTRICITY BY WINDMILLS.
(La production d'énergie électrique par
eoliennes). L. Vadot. Oct.1958. (Eng.
and Fr. text). Reprint
Houille Blanche, no.5, p.503-539 Oct.
(France) 1958

Two fundamental problems of windmill design
are considered in this article: determining
the dimensions of the machine and its out-
put. Economic and engineering considera-
tions make it possible to define the most
advantageous characteristics for a windmill.
In view of available wind power in the
Atlantic region it is of immediate interest
to use wind generators.

Windmill To-day. C.GIMPEL. Engineering v 185 n 4812
May 30 1958 p 830-30. Attempt made to follow thread of
development of wind driven generator to present day, by
examining construction of some of more important machines
built, both in Great Britain and overseas.

Wind Power: British Machine in Algeria. Engineering v
185 n 4860 Mar 7 1958 p 297-8. Test results on 100-kw Enfield.
Andreau experimental wind driven generating plant ordered
from Enfield Cables Ltd. London, erected at top of "Grand
Vent Deux"; on its initial run there, it achieved output of
130 kw.

Old-Fashioned Windmill Generates Electricity. R.WAILES.
Engineering v 186 n 4821 Aug 1 1958 p 138. Particulars of
Kraai (Crow) mill at Westbroek, near Utrecht, opened July
12, equipped for electric generation with shuttered sails and
provided with servo motor, controlled by wind vane, for turn-
ing cap.

Windmills for Electricity Supply in Remote Areas. G.
GIMPEL, A.H.STUBBART. Brit Elec & Allied Industries
Research Assoc—Tech Report C/T120 1958 24 p. Analysis of
economic and technical requirements for such windmills;
review of probable applications and of known wind conditions;
from many parts of world; it is suggested that single diameter
of wind rotor, in region of 70 ft, is likely to meet with widest
applications; recommendation for use of fixed-pitch blades in
wind rotor; choice of most economic height for windmill.

La production d'énergie électrique par éoliennes. L.VADOT.
Houille Blanche v 13 n 6 Oct 1958 p 503-25 (English translation
526-30). v 14 n 1 Jan-Feb 1959 p 3-14 (English translation
15-22). Generation of electricity by windmills; favorable use
of windpower in Atlantic regions of France; problems of
design; relation between power, diameter of rotor, and wind
speed; stresses from atmospheric turbulence; fixed and variable
pitch blades; choice of electrical equipment; weight of mechan-
ical parts varies with cube of linear dimensions; variation of
costs per kw with dimensions of rotor and height of tower.

Les aérogénérateurs à hélices en alliage léger de l'Electricité
de France. Revue de l'Atomium v 36 n 260 Dec 1958 p
1229-36. Aerogenerators with light alloy propellers of Elec-
tricité de France company; research on harnessing wind power
reported and two French generator installations described.

Wind Data Related to Generation of Electricity by Wind
Power. J.PATRIC. Brit Elec & Allied Industries Research
Assoc—Tech Report C/T116 1957 52 p. 6 plates. Purpose of
wind survey of Great Britain and Ireland was to assess
potentialities of wind as source of electrical energy; results of
potentialities analyzed; section dealing with results of wind
measurements in other countries included to help in assessing
potentialities of wind power overseas, and to compare different
wind regimes. 40 refs.

Development of Method for Measurement of Strains in Blades
of Windmill Rotor. J.C.MORRISON. Brit Elec & Allied In-
dustries Research Assoc—Tech Report C/T117 1957 28 p. 6 supp
plates. Description of electric resistance strain gages used for
blade measurements and of techniques for their positioning,
fixing and proofing; details of amplifying and recording
equipment, and of steps taken to ensure synchronization be-
tween recordings of power output of generator driven by mill,
wind speed, and strain.

N73-29004*# Scientific Translation Service, Santa Barbara,
Calif.
EXPERIMENTAL AEROGENERATOR TYPE BEST - ROMANI,
DESCRIPTION, ASSEMBLY, TEST PROGRAM
Washington NASA Aug. 1973 50 p. Transl. into ENGLISH
of the publ. "Aerogénérateur Experimental Type BEST - Romani
description - Montage Programme d'Essai" Paris, Elec. de France,
1958 54 p
(Contract NASW-2483)
(NASA-TT-F-15037) Avail: NTIS HC \$4.50 CSCL 10A
The characteristics of a propeller-driven electrical generating
machine using wind power are presented. The construction of
an installation for the equipment is described. The measurements
conducted during the performance tests are analyzed. Author

Testing of Wind-Driven Generators Operating in Parallel with Network. D.E. VILLERS. Brit Elec & Allied Industries Research Assn—Tech Report C/T116 1957 22 p. Method for establishment of steady state relationship between generator output and wind speed; tests carried out on 10-kw machine connected to public supply network; comparison of results with calculated output characteristics of machine; suggestions for further work on testing of wind driven machines connected to network or running as isolated unit.

Surveying for Wind Power in Australia. L.F. MULLETT. *Indian Engng. Australia* v 29 n 3 Mar 1957 p 69-73. Wind survey operated by Electricity Trust of South Australia is described and general level of accessible wind energy is deduced from wind recordings; cost of electricity obtainable from wind is estimated not to exceed 0.25/kw-hr for large machines and 1.5/kw-hr for small machines suitable for isolated rural systems.

Electrical Energy from Wind. E.W. GOLDING. Eng J v 40 n 6 June 1957 p 25-27. Characteristics of wind as source of power and its possibilities for generation of electrical energy; types of windmill; description of main features of some recent designs; wind power research and development work in Great Britain; economy of wind power on three scales of utilization. 22 refs.

Wind-Operated Electric Power Supply. W.A. MARRISON. *Engng* v 6 n 5 May 1957 p 418-21. System described has single rotating member and no moving electric contacts; turbine type of wind rotor is mounted on vertical shaft rotating within set of stationary deflecting blades; all wind directions are equally favorable; electric generator is of multipole rotating magnet wound stator type and generates a-c having frequency 30 times rotation speed.

Wind and Solar Energy—Proceedings of New Delhi Symposium, Oct 22-25 1954. UNESCO, Paris, 1956. 238 p. 8 supp plates. Review. D. DRESSEN. Areas for Preliminary Wind Power Surveys in India. P. NILAKANTHAN; Wind Energy in India. L. RAMDAS, K.P. RAMAKRISHNAN; Wind Machines. J.J. JULI; Planning and Balancing of Energy of Small-Output Plant. U. HERRER; Wind Energy in Arid Areas. E.W. GOLDING; Wind Power in India. R.V. RAMIAH; Wind Power Research in Israel. J. FERNKEL; Wind Power Utilization in Saurashtra. U. J. BHATT; Utilization of Wind, Solar Radiation, and Other Local Energy Sources in Arid or Semi-Arid Areas. E.W. GOLDING, M.S. THACKER; Utilization of Solar Energy. F. DANIELS; Distribution of Solar Radiation Over Earth's Surface. J.N. BLACK; Solar and Sky Radiation in Southern Africa. A.E.H. BLESLEY; Solar Radiation Prospects of Its Exploitation. V.A. HAUM; Structure of Machines Utilizing Solar Energy. F. TROMBE (in French); Methods of Capturing Solar Heat. H. MASSON (in French); Solar Work in India. L.A. RAMDAS, S. VEGANARAYANAN; Work on Solar Energy Development at National Physical Laboratory of India. K.N. MATHUR, M.L. KHANNA; Domestic Solar Water Heater. K.N. MATHUR, M.L. KHANNA; Articulated and Semi-Articulated Low-Cost Hot-Focus Solar Energy Concentrators. A.L. GARDNER; Power from Leaves. N.W. PIRIE; Studies by Andre Nizery on Thermal Energy of Sea Water, Concomitant Production of Fresh Water and Possible Preliminary Utilization of Solar Heating Tanks. M. BEAU (in French). Summaries mostly in French and Spanish.

537.1
G56

Golding, E. W.

The generation of electricity by wind power, by E.W. Golding. New York, Philosophical Library, 1956.

xvi, 318p.

1957

Harnessing Wind Energy in Arid Zones of Rajasthan, S.S. SARKAR. *Irrigation & Power*. J of Central Board of Irrigation & Power (India) v 13 n 8 July 1956 p 382-8. Modern windmill is designed to work on low velocities and yet lift water from great depths; it is capable of working on velocities as low as 4 mph attaining max efficiency at 6-7 mph; use of windmills as source of power for pumping water in Rajasthan.

Experimental Study of Wind Structure (With Reference to Design and Operation of Wind-Driven Generators). M.P. WAX. Brit Elec & Allied Industries Research Assn—Tech Report C/T114 1956 24 p. 4 plates; see also abstract in Engineering v 183 n 4786 May 8 1957 p 654-5. Studies made of wind structure at well exposed hill site using specially designed anemometer; in analysis of wind records particular attention was paid to application to problems of wind power generation; instruments and associated equipment; tests on response time of different types of anemometer; suggestions for further work. 29 refs.

1956

CN-115,145

1956

AN EXPERIMENTAL STUDY OF WIND STRUCTURE. (With Reference to the Design and Operation of Wind-Driven Generators). M.P. Wax. 1956. 24p. & illus.

British Electrical and Allied

Industries Research Association

Tech.Rept.

C/T114

Meteorology - Air - Surface layers

Meteorology - Wind

Windmills

Meteorology - Air currents, Vertical

Generators

21

P-7-16-64

587

N-51899

ON THE THEORY OF WINDMILLS. S(hun-ichi) Abe.
(Read before 25th general meeting of Japan
Soc. of Mech. Engineers, Apr.1, 1948).

see p.135-148
Reports of the Institute of High Speed
Mechanics, Tohoku U., Ser.B, v.7, 1956.

Tohoku U., Inst. of High Speed
Mechanics (Japan) Rept.
Japan Society of Mechanical 67
Engineers Apr.1,
1948
Author

The theory of windmills under constant wind
speed is stated with special reference to
effect of number of blades, mutual inter-
ference of blade elements to the lift
coefficient, effect of the induced rota-
tional velocity in the slipstream and
starting characteristics. The power coeffi-
cient of models calculated by theory is
shown to coincide fairly well with experi-
mental results
X650/(ALO(Pt.6))/6

N-48112

A PRELIMINARY REPORT ON THE DESIGN AND PER-
FORMANCE OF DUCTED WINDMILLS. G.M. Lilley
and W.J. Rainbird. Apr.1956. 72p. diagrs.,
tabs. Coll. of Aeronautics (St.Brit.)

College of Aeronautics (St.Brit.) Rept.102
Authors (2)

A preliminary study is made of theoretical
gain in power output obtained with a fully
ducted land-type windmill as compared with
the standard unshrouded type windmill. The
design of the internal and external ducting
is discussed together with its effects on
the overall performance of the windmill. The
differences in the aerodynamic design of the
blades for the ducted and unshrouded wind-
mills are considered and attention is drawn
to the importance of the use of the correct
induced (or interference) velocities. A
brief review is included of recent Japanese
theoretical and experimental studies on
ducted windmills.

9245/C-RS/2-19-57/10

551.51

Aul

The wind as a source of energy.
pp.123-136.

In: Man and the Wind.

1955.

(Chapt. XII).

Windmills

Windmill blades

Windmills

Fans, Duct

Flow - Ducts

Ducts - Pressure drop

Windmill blades

Screens - Pressure drop

N74-16803*# Linguistic Systems, Inc., Cambridge, Mass.

A WIND PLANT TO POWER SEA SIGNALS
F. Baumeister Washington NSA Feb. 1974 17 p Transl.
into ENGLISH from elektrotech. Z. (Berlin-Charlottenburg). v. 7.
no. 12. 21 Dec. 1955 p 437-441
(Contract NASw-2482)

On the basis of the experience with the Schleimunde
windpower plant, it may be said in conclusion that economic
operation of such a windpower plant is feasible whenever, on
the one hand, the cost of connecting the consumers to the
public network is prohibitive, and on the other hand sufficient
wind is available. The planning of long term duration and force
reading is of particular value. It is advantageous to erect windpower
plants in coastal and mountain regions. Author

Wind-Driven Generator on Coast Head. Engineering v 180
n 1067 July 8 1955 p 65-7; see also Engineering v 200 n 5189
July 8 1955 p 43-4; Surveyor v 114 n 3303 June 23 1955 p
654. Operational experience at very exposed sea in Orkney;
plant erected by John Brown & Co (Clydebank), designed to
give output of 100 kw with rated wind speed of 35 mph;
center of rotor is 78 ft above ground, and swept diam of
3-bladed rotor is 60 ft; nacelle mounted on pivot shaft to
allow windmill to be yawed round to suit direction of wind;
fixed and floating bipoles of welded steel framework; blade
spars made of compressed laminated wood.

Wind Energy. E.W.GOLDING. Instn Elec Engrs-J v 1 n
2 Feb 1956 p 70-2; see also Engineering v 179 n 4654 Apr 8
1955 p 433-4. Three well defined scales of utilization for
different purposes are: small scale, using machines of capacity
up to 10 kw at remote individual premises; medium scale,
with machines of 10 to 100 kw to provide energy needs of
isolated communities; large scale, in which wind driven a-c
generators, of 100 kw upwards to perhaps 2000 or 3000 kw,
feed output directly into main networks.

Wind-Generated Electricity. Engineering v 179 n 4652 Mar
25 1955 p 371-4. Experiments conducted with new type of
wind driven synchronous induction alternator on site at Präs
Wood, near St. Albans, built for British Electricity Authority
as part of their investigations into use of wind power for
generating electricity; generator works on "depression" prin-
ciple; propeller blades are hollow, and as force of wind makes
them rotate, air is discharged through blade tip outlets due
to centrifugal action.

N74-17787*# Linguistic Systems, Inc., Cambridge, Mass.
THE PRESENT STATUS OF HONNEF WIND POWER
PLANTS

P. Juchem Washington NASA Feb. 1974 19 p refs Transl.
into ENGLISH from Elektrotech. Z. (West Germany). Ausgabe
B, v. 7, no. 5, 21 May 1955 p 187-191

(Contract NASw-2482)

(NASA-TT-F-15355) Avail: NTIS HC \$4.00 CSCL 10A

The most important energy sources on earth, next to the
sun and water, are coal and oil. However, it seems that these
deposits will be exhausted in the foreseeable future. Large
windpower plants are destined to play an important role in the
tapping of new energy sources. Their viability must be judged
from the research and development work carried out in the
Author

EQ 7

1955

1955

1955

N74-15747*# Scientific Translation Service, Santa Barbara, Calif.
CHARACTERISTIC LINES (YEARLY PERMANENT LEVEL LINES) AND CHARACTERISTIC WIND VARIABLES FOR WIND ENERGY PRODUCTION
 H. Pigge Washington NASA Feb. 1974 25 p refs Transl. into ENGLISH from Elektrizitaetswirtschaft (Frankfurt am Main), v. 54, no. 20, Oct. 1955 p 704-709
 (Contract NASw-2483)

(NASA-TT-F-15354) Avail: NTIS HC \$3.25 CSCL 10B
 Optimum design methods for wind driven electrical generating plants are presented, based on yearly permanent wind level lines for selected erection sites. Wind conditions at any site are divided into five classes, of which only a few can be exploited by a given system. General purpose design curves are given.
 Author

Golding, E. W., "The Generation of Electricity by Wind Power," Philosophical Library, Inc., New York, 1955.

(out of print 1970)

"Energy From the Wind," Technical Note No. 4, World Meteorological Organization, 1954, WMO-No. 32, T.P. 10, Geneva, Switzerland.

Economic Value of Hydrogen Produced by Wind Power.
 A.H. STODHART, Brit Elec & Allied Industries Research Assn.—Tech Report C/T111 1954 8 p. Circumstances under which possible use of windpower to produce hydrogen might be considered; estimated costs of providing heat, light and power in this way are compared with those of obtaining energy in similar forms by use of either paraffin or diesel oil; examples based on cost of fuel at semi-desert site and at inland site are given.

1954

N73-25008*# Scientific Translation Service, Santa Barbara, Calif.
THE DEVELOPMENT OF WIND POWER INSTALLATIONS FOR ELECTRICAL POWER GENERATION IN GERMANY
 Ulrich Huettner Washington NASA Aug. 1973 32 p refs Transl. into ENGLISH from Z. Brennst.-Waerme-Kraft (Duesseldorf), v. 6, no. 7, 1954 p 270-278
 (Contract NASw-2483)

The development of installations for reducing electrical energy from wind energy is beginning in Germany. The wind tower generation installations built by German firms have a wheel area of between 50 to 250 square meters for installed power levels between 3 and 50 kW. In the last 30 years, there has been a tendency to increase the design rotation rate coefficient from 2.4 to a level between 8-16. At the present time, there are reliable installations with nominal power levels between 3 and 22 kW. Successful Danish, American, Russian, and German experiments over prolonged time periods proved that it is possible to operate wind power generation units in parallel with public high-voltage installations without any difficulty. This means that wind energy is now available to satisfy the energy requirement which is continuously increasing all over the world. A rough calculation shows that the energy capacity of the ocean of air is unlimited.
 Author

AMERICAN WIND TURBINE.

R.H. Nilberg.

Can. J. Phys., v.32, no.10, Oct.1954, p.639-52.

Theory of low speed wind turbine showing that shape of airfoil blade is predetermined by theoretical deflection of air stream; efficiency of 20% is predicted.

N73-21253*# Kanner (Leo) Associates, Redwood City, Calif.
PRINCIPLES OF STEEL CONSTRUCTION ENGINEERING IN THE BUILDING AND OPERATION OF WIND DRIVEN POWER PLANTS
 Helmut Voigt Washington NASA Apr. 1973 13 p ref Transl. into ENGLISH from Der Stahlbau (West Germany), v. 23, no. 8, Aug. 1954 p 184-188
 (Contract NASw-2481)

(NASA-TT-F-14872) Avail: NTIS HC \$3.00 CSCL 13B
 The factors which affect the designing of wind-driven power plants are discussed, including purpose and nominal output, wind velocity as a function of height, wind forces as a function of height, and the torques to be expected. Design features of the ZYKLON wind-driven power plants are summarized, and sample calculations are made, based on the ZYKLON-D 30 project. The optimal shaft height for a 30-m wind turbine is found to be 50 m above ground, with a yearly output of 2,125,000 kWh at a cost of 2.68 German pfennigs per kWh.
 Author

FITTING WIND POWER TO THE UTILITY NETWORK

February 1954

Percy H. Thomas

Federal Power Commission
Washington, D. C.

This is the last of the four monographs published by the Federal Power Commission relative to the studies made by Mr. Thomas in the 1944-1954 period regarding wind powered electric generation.

The author's prior works involved highly technical and specific design matters, particularly in the field of aerodynamics. This shorter work was largely general in nature, commenting on the utilization, or integration, of wind generated electric energy in an electric utility network. He discussed generally the possible benefits of firm and secondary power derived from wind powered generation when supported by large interconnected electric systems. By this time, steam-electric generating units having 250,000-kilowatt capacities were in operation, and the economic benefits of economy of scale of these units presented, at that time, a stiff challenge to competing electric generation sources. In this monograph, Mr. Thomas moved away from comparative cost based justification for wind powered generation in favor of more general statements; i.e., justification would be sufficient if steam generation costs were met. He also stated, regarding wind powered electric generation and to a degree at variance with earlier implications, that economies of scale were of questionable attainment, and he implied that units having 2,000- to 4,000-kilowatt capacities might yield maximum economic benefits.

In previous publications, Mr. Thomas had made some references to the use of wind mills to generate mechanical power, not necessarily associated with conversion to electric energy. In this work, he also commented on a wind-powered water pump and some general applications, including its use as the pumping source for hydroelectric pumped storage operations.

1953

Possibilities of Wind Power. Engineering v 176 n 4563 July 10 1953 p 33; see also Machinery Market n 2747 July 10 1953 p 25-6. Some applications reviewed: exhibition of equipment for application of wind power staged by Enfield Cables, at Frae Wood, near St. Albans, include 100-kw wind generator erected at Frae Wood, working on "depression" principle, and 8.5-m 8-kw plant, of similar type built by Ateliers et Chantiers de France, S.A., Paris.

Prospects for Windpower Development in Ireland. H. MUNRO. Instn Civ Engrs of Ireland. Trans v 79 1953 p 128-57 (discussion) 159-67, supp plate. List of long term annual average wind speed m/sec; pattern of windmill operation; choice of rated wind speed; aerodynamics of windwheel blade; construction of windmill; present position in windpower development and prospects.

Wind Power History and Present Status. H.E. PARSON. Eng J v 36 n 1 Jan 1953 p 19-21. Development in East 40 yr; A. Flettner in Germany and J.D. Madaras in United States sought to harness Maguau effect, i.e., side thrust exerted by cylindrical surface revolving in wind stream; installations of 6-blade windmill connected to vertical shaft generator in 1920 by Kummie in Germany; other installations in Germany, Finland, United States, and Russia; largest and best engineered experiment in large scale wind power generation, was Grandpa's Knob experiment in Vermont.

N74-16801*# Linguistic Systems, Inc., Cambridge, Mass.
USING THE ENERGY OF THE WIND FOR ELECTRIFICATION
V. R. Sektorov Washington NASA Feb. 1974 18 p Transl.
into ENGLISH from Elektrichstvo, (USSR), no. 3 March 1953 p 11-16
(Contract NASw-2482)
(NASA-TT-F-15307) Avail: NTIS HC \$4.00 CSCL 10A

The utilization of wind energy for generating electric power is discussed. Existing power generators utilizing wind energy are described and their use in agriculture is indicated. Author

The experimental and theoretical investigations of windmills, by Matsunosuke Iwasaki.

N-28867

Reprint from: Kyushu (Imperial) Univ.,
Research Institute for Applied Mechanics,
Repts., v.2, no.8, Dec., 1953, p.181-229
incl.5 tabs., 22 figs. (curves)

9092

591

An extension of the momentum theory of wind turbines,
by H.H. Rosenbrock.
Aircraft Engineering, v.24, no.282, Aug., 1952,
p.226-227, illus.

1952

Review of Wind Power Developments. J.H.M. SYKES. Elec Engr & Merchandise v 27 n 5 AUG 1952 p 148-50. Design of wind generator that would produce satisfactory output of a-c power which could be fed into public supply network has been attended by number of difficulties, especially need with orthodox windmill to mount generator at top of tower; description of Enfield-Andreas generator; by novel method of using wind pressure, electric generator can be mounted at foot of tower; machine of this type is now under test in England and will be installed on Welsh coast for further experimental operation.

Power Generation by Wind. C.W. MARSHALL. Engineering v 174 n 4497 Apr 1953 p 445-6. Experience with wind motors, it is claimed, does not encourage large scale investment in wind power developments; tentative conclusion reached that most economical capacity of generator for operation with British grid system lies between 1000 and 2000 kw; North of Scotland Hydro-Electric Board machine is 100-kw geared unit, with 3-bladed propeller and asynchronous generator; British Electricity Authority machine is Andreas type, with pneumatic transmission and asynchronous generator. Before Roy Soc Arts.

Selection and Characteristics of Wind-Power Sites. E.W. GOLDING. A.H. STODHART. Brit Elec & Allied Industries Research Assn—Tech Report C/T108 1952 32 p. 7s. Development, throughout its various stages, of wind survey covering areas of British Isles most likely to contain sites suitable for large scale generation of electricity by wind power; results of measurements analyzed and comparison of wind flow at sites is made; estimates of wind energy available and proportion which may be usable by air generator.

Possibilities of Wind Power Plants in India. K.M. SANKARAN. Power Engr (India) v 2 n 1 Jan 1952 p 14-8. Wind power, if harnessed, would substantially aid hydro power system to firm up their capacity; possibilities in India; examples of installations abroad.

Critical Intermittent Impact Factor in Wind-Turbine Design. P.H. THOMAS. Water Power v 4 n 1 Jan 1952 p 25-6. Function of impact in performance of wind turbines; proper appreciation of this factor can lead to more efficient designs.

1952

Behavior and performance of flow engines, by Friedrich Wagner.
Aug., 1952. 46 p., illus.

Municipal Univ. of Wichita, Bull. N-24859
Eng. Study 080.
Contract N-onr-20101.

1952

N74-15763*# Scientific Translation Service, Santa Barbara, Calif.

ANTENNA TOWERS AS WIND TOWER GENERATION PLANTS

H. Pigge Washington NASA Feb. 1974 10 p refs Transl. into ENGLISH from Elektrotech. Z. (West Berlin), v. 73, no. 4, 15 Feb. 1952 p 95-96 (Contract NASw-2483)

(NASA-TT-F-15304) Avail: NTIS HC \$3.00 CSCL 10B
A variety of wind power generating plants are considered to be installed on FM antenna masts. These include: Savonius rotor, horizontal axis wind wheels, multi-rotor configurations. Power levels vary between 10-20 kW for 100 meter mast heights. Author

N74-15739*# Scientific Translation Service, Santa Barbara, Calif.
HIGH POWERED ELECTRICAL POWER GENERATION BY WIND MOTORS

M. Kloss Washington NASA Feb. 1974 11 p ref Transl. into ENGLISH from Elektrotech. Z. (West Berlin), v. 72, no. 7, 1 Apr. 1951 p 201-202 (Contract NASw-2483)

(NASA-TT-F-15303) Avail: NTIS HC \$3.00 CSCL 10A
The development of a wind wheel for electric power generation is discussed. The interaction between the wind wheel and the generator is accomplished with a power control device to prevent overloading the generator when the wind velocity increases. The self-controlled running wheel of the wind motor adjusts the blade angle of attack to compensate for the wind velocity. The generator must be dimensioned for the greatest wind intensity in order to accept the entire wind wheel power. The wind generation installation delivers all of the produced energy to the network so that other generating stations operating in parallel and the storage units must adjust the power level to the consumers. Author

Extension of Momentum Theory of Wind Turbines, H. H. ROSENBRUCK. *Brit Elec & Allied Industries Research Assn Tech Report C/T106* 1961 12 p. 6a; see also Aircraft Eng v 24 n 282 Aug 1962 p 226-7. Momentum theory of wind turbine, as usually stated, does not allow interference factors greater than one-half, although experiment shows that values approaching unity are possible; theory is extended to remove this contradiction, and assumptions are at same time slightly generalized.

What Can Wind Power Do For Us? G.A. WHEATSTONE. *Power Eng v 55* n 3 Mar 1961 p 72-3. Appraisal of value of wind power to public utility system indicates that wind power is technically feasible; it is probably non-competitive at present; there are few duties for which wind alone is adequate; combination of wind power with internal combustion power, and combination with hydro power with seasonal storage both have some strong advantages.

Wind Power, P. H. THOMAS. *Water Power v 3* n 8 Aug 1951 p 302-4. Various aspects of using wind power and its potentialities as contribution of energy to utility network system; appraising probable value of wind energy for power purposes; measurement of wind energy in United States; comments on aerogenerators.

N74-15740*# Techtran Corp., Glen Burnie, Md.
NEUWERK WINDMILL POWER GENERATION PLANT
W. Mackenthun Washington NASA Jan. 1974 12 p refs Transl. into ENGLISH from Elektrizitätswirtschaft (Frankfurt am Main), no. 11, Nov. 1951 p 322-325 (Contract NASw-2485)

(NASA-TT-F-15306) Avail: NTIS HC \$3.00 CSCL 10A
The installation and characteristics of a windmill power generation plant are discussed. The meteorological parameters of the German North Sea Coast which influenced the location of the windmill power generating system are analyzed. The regulating devices for compensating for changes in wind velocity are described. Results of the power generation operation for the year 1950 are tabulated. Author

N74-16756*# Linguistic Systems, Inc., Cambridge, Mass.
EXPLOITATION OF WIND ENERGY
Hans Christaller Washington NASA Feb. 1974 12 p refs Transl. into ENGLISH from Elektrizitätswirtschaft (West Germany), v. 50, no. 11, Nov. 1951 p 320-322 (Contract NASw-2482)

(NASA-TT-F-15309) Avail: NTIS HC \$3.00 CSCL 10B
The utilization of wind power is discussed. A measurement is made of the energy available from air currents. Wind turbulence is calculated together with the average power. The structural features of windmills are discussed in relation to possible industrial applications. Author

Harnessing Britain's Gales. A. MIDDLETON. Compressed Air Mag v 55 n 3 Mar 1950 p 70-1. Illustrated notes on ancient and modern windmills used in Great Britain.

Orkney Windmill and Wind Power in Scotland. J. VENTERS. Engineer v 189 n 7405 Jan 27 1950 p 106-8. 100-kw windmill ordered by North of Scotland Hydro-Electric Board; considerations which led Hydro Board to embark on experiment; why windmill is being erected in Orkney; and why its rating is 100-kw; wind power as source of energy; estimate of accessible wind energy; practical aspects of problem.

Un impianto aereo-elettrico pilota di media potenza con accumulo idrico di pompaggio. R. VEZZANI. Elettrotecnica v 37 n 9 Sept 1950 p 398-419. See also English abstract in Engrs Digest v 12 n 5 May 1951 p 158-62. Air motor power plant to be erected on island of Giglio, Italy; slow speed orientable windmill designs are replaced by high speed air motors, protected and fixed in space; entire air motor is placed in tubular system similar to Venturi tube; operation of enclosed air motor may be regarded as similar to that of Kaplan turbine; diagram.

N74-15755*# Kanner (Leo) Associates, Redwood City, Calif.
MEDIUM-CAPACITY AIR MOTOR PILOT PLANT WITH HYDRAULIC ENERGY ACCUMULATION BY PUMPING
Renzo Vezzani Washington NASA Feb. 1974 72 p refs
Transl. into ENGLISH from Elettrotecnica (Italy). v. 37. 15-25 Sep. 1950 p 398-419
(Contract NASw-2481)

(NASA-TT-F-15299) Avail: NTIS HC \$5.75 CSCL 10B

An air motor power plant is to be erected on the island of Giglio, Italy. Slow speed orientable windmill designs are replaced by high speed air motors, protected and fixed in space. The entire air motor is placed in a tubular system similar to a Venturi tube. The operation of the enclosed air motor may be regarded as similar to that of a Kaplan turbine.
Author

N74-15751*# Scientific Translation Service, Santa Barbara, Calif.

UTILIZATION OF WIND POWER WITH WARD-LEONARD TYPE CIRCUIT IN INVERTED OPERATION

A. Carrer Washington NASA Feb. 1974 13 p Transl. into ENGLISH from Elettrotecnica (Italy). v. 36. 10-25 Aug. 1949 p 383-385
(Contract NASw-2483)

(NASA-TT-F-15352) Avail: NTIS HC \$3.00 CSCL 10B

An electric circuit is described comprising two direct current machines and one three-phase synchronous or an asynchronous induction machine suitable for transforming and feeding the energy from the wind into a three-phase conventional electric power network.
Author

Potentialities of Wind Power for Electricity Generation (with Special Reference to Small-Scale Operation). E.W. GOLDING and A.H. STODHART. Brit Elec & Allied Industries Research Assoc. Tech Report Ref W/T16 1949 26 p. 15-6d; see also abstract in Engineer v 188 n 4886 Sept 16 1949 p 326-7; Elec Times v 116 n 3017 Sept 1. 1949 p 335; Elec v 143 n 3716 Sept 2 1949 p 743-4. Wind statistics for Great Britain analyzed and estimates given of power and annual energy likely to be available at various sites in different districts; probable costs of generation by wind driven generators of different output ratings.

Electricity Generation by Wind Power. Engineering v 168 n 4377 Dec 16 1949 p 647-8. Review of two reports published by Electrical Research Assn.; Technical Report Reference W/T16, Potentialities of Wind Power for Electricity Generation (with Special Reference to Small Scale Operation), and Technical Report Reference C/T101, Large Scale Generation of Electricity by Wind Power—Preliminary Report.

Harnessing Wind for Electric Power. P.H. THOMAS. Civ Eng (Lond) v 43 n 517 July 1949 p 387-90. Review of ways and means by which bulk electric power may be obtained from wind; description of different types of wind turbines. Before United Nations Scientific Conference.

Wind Power. Mech World v 126 n 3276 Oct 28 1949 p 318-9. Summary of report on development of wind power utilization in Netherlands. From paper before United Nations Sci Conference on Conservation & Utilization of Resources.

History. Norfolk Corp. Mill R. WAILLES. Engineering v 168 n 4360 4361 Aug 19 1949 p 189-92. Aug 26 p 213-16. Paper based on notes made of nine post mills, seven smock mills, 69 tower mills and two composite mills; fanmills were universal, 6 or 8 blades being used; photographs. Paper presented at Newcomen Soc.

Large-Scale Generation of Electricity by Wind Power—Preliminary Report. E.W. GOLDING. Brit Elec & Allied Industries Research Assn.—Tech Report Ref C/T101 1949 15 p. 1/6d. Description of steps which are being taken to determine possibilities of this method of generation in Great Britain and account of results obtained so far in investigations; suggestions are made concerning future research and development.

N74-15770*# Scientific Translation Service, Santa Barbara, Calif.

SMALL WIND-ELECTRICAL INSTALLATIONS FOR EXPORT

G. R. Seidel Washington NASA Feb. 1974 11 p refs
Transl. into ENGLISH from Elektrotech. Z. (West German). v. 70. no. 5. May 1949. p 158-160
(Contract NASw-2483)

(NASA-TT-F-15350) Avail: NTIS HC \$3.00 CSCL 10B

The design and operational problems are reported that are associated with wind power generating plants similar to the American wind charger. The potential market for such devices is discussed.
Author

1949

N74-15760*# Kanner (Leo) Associates, Redwood City, Calif.
INVESTIGATION OF THE POSSIBILITIES OF USING WIND POWER

C. Kromann and J. Juul Washington NASA Feb. 1974 11 p
Transl. into ENGLISH from Elektroteknikeren (Denmark), v. 45,
7 Dec. 1949 p 711-714
(Contract NASw-2481)

(NASA-TT-F-15336) Avail: NTIS HC \$3.00 CSCL 10B
Kromann's critique of several of Juul's articles in Elektroteknikeren and of Juul's iposte is reported. For example, Kromann argues that it should not be expected that wind tunnel experiments, necessary as these are for finding the best vane design, will yield the same results as real conditions; Juul counters that the same efficiency can be obtained in the open air as in a wind tunnel and that, in any case, this point will be investigated in greater detail in the near future. Kromann has misgivings about building windmills on the west coast of Jylland because he fears that the force of the wind there is too variable; Juul counters that wind force measurements show that this fear is unfounded (the corresponding curves are given).
Author

1949

N74-17792*# Kanner (Leo) Associates, Redwood City, Calif.
WIND POWER, PART 2 - ECONOMIC FEASIBILITY, 1949
G. Lacroix Washington NASA Mar. 1974 23 p refs Transl.
into ENGLISH from Tech. Mod. (France), v. 41, nos. 7, 8, 1-5 Apr. 1949
(Contract NASw-2481)

(NASA-TT-F-15419) Avail: NTIS HC \$4.25 CSCL 10A
Both classical and theoretical methods for preventing wind engines from overspeeding are described. The greatest drawback in the use of these devices is seen to be their inability to compete with other power sources on an economic basis. In this connection there is a detailed description of the failure of the Grandpa's Knob experiment conducted in Vermont in the early 1940's; the technical defects were minor in comparison to the lack of economic feasibility. Russian efforts and Danish projects are discussed briefly.
Author

N74-15764*# Kanner (Leo) Associates, Redwood City, Calif.
WIND ENERGY
G. Lacroix Washington NASA Feb. 1974 28 p refs Transl.
into ENGLISH from Tech. Mod. (Paris), v. 41, nos. 5 and 6, 1 and 15 Mar. 1949 p 77-83
(Contract NASw-2481)

(NASA-TT-F-15342) Avail: NTIS HC \$3.50 CSCL 10B
The technical and economic problems involved in the use of wind engines as a source of power are discussed, with detailed descriptions of the operative principles behind several basic types.
Author

1949

N74-15768*# Kanner (Leo) Associates, Redwood City, Calif.
PROSPECTS FOR THE UTILIZATION OF WIND ENERGY IN CZECHOSLOVAKIA

F. Sembera Washington NASA Feb. 1974 25 p Transl.
into ENGLISH from Elektrotechnicky Otvor (Czechoslovakia), v. 38, Sep. 1949 p 477-484
(Contract NASw-2481)

(NASA-TT-F-15305) Avail: NTIS HC \$3.25 CSCL 10B
Technical and economical conditions for the utilization of wind velocities in various districts of the country, their number and the probable daily and yearly charts at various altitudes, and the most windy districts, the possibilities and extent of utilizing the airstreams by power stations equipped with prime movers with a 50 m propeller diameter and a 30-35 m high tower are investigated and presented on the basis of many years of observation. It is determined that the power stations in Czechoslovakia should have a maximum output of 500 kW and a yearly production of about 700,000 to 800,000 kWh, so that 1000 such stations could replace the power plant in Enverice. The probable cost per kWh generated in the wind power plant is calculated on the basis of the proposed estimate for the capital investment and economical results are evaluated based on this solution, which are not practical in the near future. Author

Putnam, C., "Power From the Wind," D. Van Nostrand Co., New York, 1948.

Record of wind turbine experiment conducted in Vermont by group of scientists and engineers; purpose was to find out by abilities of generating electricity on large scale by harnessing wind; book summarizes various technical problems encountered, attempts at solving them, and findings and discoveries made.

N74-15782*# Scientific Translation Service, Santa Barbara, Calif.

PARALLEL OPERATION OF A SYNCHRONOUS GENERATOR AND AN INFINITELY HIGH-POWERED NETWORK WHEN DRIVEN BY A HOMER-GROSS WIND TURBINE
Ludwig Liner Washington NASA Feb. 1974 14 p refs
Transl. into ENGLISH from Elektrotech. Z. (West Berlin), v. 69,
no. 9, Sep. 1948 p 293-296
(Contract NASw-2483)

(NASA-TT-F-15302) Avail: NTIS HC \$3.00 CSCL 10B
An infinite high powered network is described as a network whose voltage is independent of the load states of the connected machines, and whose voltage amplitude and angular velocity is always the same. The three-phase generator operating in conjunction with this network must operate at a constant rotation rate, as must the wind wheel according to the number of its poles and the frequency of the network. The variation in the power output of a wind wheel is discussed for constant rotation rate as a function of wind velocity in order to evaluate the operational characteristics of a synchronous machine. Author

AERODYNAMICS OF THE WIND TURBINE

January 1949

Percy H. Thomas

Federal Power Commission
Washington, D. C.

In this monograph, the author compares the detailed aerodynamic designs of the Grandpa's Knob unit, an English design, with his design. Mr. Thomas modified his 1946 design of a 7,500-kilowatt unit for this comparison by increasing the blades from two to three for each wheel, shortening each blade, and increasing the designed rotational speed.

Mr. Thomas again emphasized that, because of intangible characteristics and uncertainties of extrapolations, wind tunnel tests and full scale prototype construction were imperative to fix a design.

THE WIND POWER AEROGENERATOR -- TWIN WHEEL TYPE

March 1946

Percy H. Thomas

Federal Power Commission
Washington, D. C.

This monograph is devoted to the detailed design features of the twin wheel, 7,500- and 6,500-kilowatt wind powered generators discussed in the previous monograph.

The author commented on the March 1945 shutdown of the 1,000-kilowatt Grandpa's Knob unit, and he reiterated the desirability of larger units having capacities between 5,000 and 10,000 kilowatts for utility operation.

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N74-10948* # Linguistic Systems, Inc., Cambridge, Mass.
**INFLUENCE OF WIND FREQUENCY ON ROTATIONAL
 SPEED ADJUSTMENTS OF WINDMILL GENERATORS**
 Ulrich Hutter Washington NASA Nov. 1973 17 p Transl.
 into ENGLISH from Z. Elektrotech. (Stuttgart), v. 1, no. 6, 1948
 p 117-122

(Contract NASw-2482)

(NASA-TT-F-15184) Avail: NTIS HC \$3.00 CSCL 10A

In installing groups of windmill generators to produce electric power from the force of the wind, it is important to locate the units of such a network in such fashion that the so-called two-minute variation of the wind velocity can be overcome. This is done by using at least three windmill generators located an appropriate distance apart. When the wind velocity is insufficiently great to drive the blades of the windmills, a source of power should be available (battery, power from other windmills) to keep the blades turning. Contrary to popular misconception, changing the angle of attack of the windmill blades does not improve the efficiency of their operation or increase the power of the windmill. Author

N73-23011* # Scientific Translation Service, Santa Barbara, Calif.
**UTILIZATION OF WIND POWER BY MEANS OF ELEVATED
 WIND POWER PLANTS**
 F. Kellinenz Washington NASA May 1973 30 p refs
 Transl into ENGLISH from Technik (East Berlin), v. 2, no. 12,
 Dec. 1947 p 517-523

(NASA-TT-F-14903) Avail: NTIS HC \$3.50 CSCL 13B

Exploitation of wind power by power plants at high altitudes is considered. A design of a wind power plant is proposed and its efficiency and economy in the framework of present conditions in Germany is demonstrated. Although costs are higher than for a coal fired steam plant, they compare favorably with hydroelectric power plants and the saving of coal is a great advantage. The erection of an experimental plant is recommended. Author

N74-15745* # Kanner (Leo) Associates, Redwood City, Calif.
**OBSERVATIONS ON MODERN WIND-ELECTRIC POWER
 PLANTS**

G. Serragli Washington NASA Feb. 1974 22 p refs Transl.
 into ENGLISH from Elettrotecnica (Italy), v. 34, 10-25 Dec. 1947
 p 494-498

(Contract NASw-2481)

(NASA-TT-F-15357) Avail: NTIS HC \$3.25 CSCL 10B

Development of the aeronautical type windmill design and the installation of wind-powered electricity plants is held feasible for Italy undergoing post-war reconstruction. It is shown to be possible to build from 200 to 300 small capacity power plants for a total output of 10,000 to 15,000 kW in areas of Italy which have the minimum necessary wind speed of 5.5 m/sec. Among the designs required for such wind electricity plants are windmill blades with variable pitch, automatic pitch control system which does not use the costly servomotor, and reversible wheels. These features enable a windmill of limited orientability to function with high efficiency. The effect of wind rose patterns, the surface area of the blade, and some possible local uses of the electricity produced by such plants are also discussed. Author

N74-15749* # Kanner (Leo) Associates, Redwood City, Calif.
**PROBLEMS IN THE ELECTRICAL EQUIPMENT OF WIND
 POWER PLANTS**
 M. Kloss Washington NASA Feb. 1974 42 p refs Transl.
 into ENGLISH from Technik (Berlin), v. 2, Nov. 1947
 p 471-479

(Contract NASw-2481)

(NASA-TT-F-15312) Avail: NTIS HC \$4.25 CSCL 10B

Problems encountered in electric installations of wind power plants are discussed. Difficulties involved necessitate close cooperation of aerodynamic and electrical engineer in implementing wind power plants for d-c and a-c currents. Examples of actual installations in Germany are presented; a present task is erection of small wind power plants for farms. Author

N74-15750* # Scientific Translation Service, Santa Barbara, Calif.

**THE LARGE SCALE WIND DRIVEN ELECTRICAL GENERAT-
 ING STATION**

H. Mayer Washington NASA Feb. 1974 10 p refs Transl.
 into ENGLISH from Technik (Berlin), v. 2, no. 12, Dec. 1947
 p 527-528

(Contract NASw-2483)

(NASA-TT-F-15313) Avail: NTIS HC \$3.00 CSCL 10B

Large wind power plants and their use to alleviate coal shortage in Germany are discussed. It is stipulated that there is no economic necessity for development of large scale wind power plants before possible improvements in steam power plants, such as combined heating and power plants, high pressure plants, etc. have been exhausted. A table gives comparison of costs and efficiency of wind and steam power plants. Author

N74-15753* # Kanner (Leo) Associates, Redwood City, Calif.
**APPLICATION OF WIND POWER TO RATIONAL GENERA-
 TION OF ELECTRICITY**

J. Juuls Washington NASA Feb. 1974 28 p refs Transl.
 into ENGLISH from Elektrotekniker (Denmark), v. 43, 7 Aug.
 1947 p 137-148

(Contract NASw-2481)

(NASA-TT-F-15334) Avail: NTIS HC \$3.50 CSCL 10B

The history and development of windmills in Denmark and elsewhere is sketched. The costs and problems of generating electricity by steam, water and wind power are compared. Pointing out that the wind is Denmark's only major natural source of power and dividing the application of wind power into an economic and a technological part, it is discussed how the Danish wind could be harnessed to supply power not only in the requisite amounts and at the lowest cost, but also under all circumstances, so as to make Denmark self-sufficient in the matter of energy. Author

1947

N74-15769*# Scientific Translation Service, Santa Barbara, Calif.
THE UTILIZATION OF THE WIND ENERGY
 Renzo Vezzani Washington NASA Feb. 1974 11 p Transl.
 into ENGLISH from Elettrotecnica (Milan), v. 34, Nov. 1947
 p. 463-464
 (Contract NASw-2483)
 (NASA-TT-F-15344) Avail: NTIS HC \$3.00 CSCL 10B
 Wind energy exploitation by very large wind power generating stations is discussed. This system is compared to other types of power generation.
 Author

Windmills

Aerodynamic computations for the wind turbine.
 A critical analysis.- By Percy H. Thomas.
 Mar., 1946. 95 p., incl. tab.
 12 figs. (diagrams, curves, charts)

Federal Power Commission, Office of the Chief Engineer.

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1946

N74-15734*# Kanner (Leo) Associates, Redwood City, Calif.
WIND ENERGY: ITS VALUE AND THE CHOICE OF SITE FOR EXPLOITATION
 P. Ailleret Washington NASA Jan. 1974 20 p Transl into ENGLISH from Rev. Gen. Elec. (Paris), v. 55, Mar. 1946
 p. 103-108
 (Contract NASw-2481)
 (NASA-TT-F-15311) Avail: NTIS HC \$3.00 CSCL 10A
 The problem of wind power utilization is discussed, including determination of wind power per square meter obtained yearly from surfaces subjected to wind action, and systematic prospecting for favorable sites using a simple anemometric device which calculates wind speed with the aid of a special electric meter. A description is given of a program for site selection which will make it possible to determine the energy which can be produced by the wind engines used.
 Author

"Final Report, Wind Turbine Project (W.P.D.144), (1946), by New York University College of Engineering, P.B. 25370, Office of Technical Services, U.S. Government.

LARGE WIND-DRIVEN SYNCHRONOUS GENERATORS.
 T.F. Wall.
 Engineering, May 28, 1943, p.421-3, Pt.1.
 Engineering, June 11, 1943, p.461-3, Pt.2.
 Engineering, June 25, 1943, p.501-3, Pt.3.

1943

N74-15767*# Kanner (Leo) Associates, Redwood City, Calif.
NEW WIND POWER STATION
 E. Rogge and D. Stein Washington NASA Feb. 1974 21 p
 refs Transl. into ENGLISH from Elektrizitaetswirtschaft (West Germany), v. 42, no. 14, 5 Nov. 1943 p. 358-363
 (Contract NASw-2481)
 (NASA-TT-F-15332) Avail: NTIS HC \$3.25 CSCL 10B

A wind power plant is described which was used during the fuel shortage that occurred in World War 2. Unlike ordinary wind power plants which produced usable power only at wind velocities above 4 or 5 m/s, this power plant was designed to operate over a wide range, charging its battery at low wind speeds, delivering usable power from generator and discharging battery at intermediate speeds, and delivering power and charging its batteries at high wind speeds. The result was exploitation of the wind for a larger number of hours per year and lower costs per kWh of output.
 Author

N74-15754*# Scientific Translation Service, Santa Barbara, Calif.
IMPORTANCE AND PROGRESS OF WIND POWER UTILIZATION IN DENMARK
 Dimitry Stern Washington NASA Feb. 1974 19 p Transl. into ENGLISH from Elektrizitaetswirtschaft (Frankfurt am Main), v. 41, no. 16, 20 Aug. 1942 p. 370-374
 (Contract NASw-2483)
 (NASA-TT-F-15349) Avail: NTIS HC \$3.00 CSCL 10B

The designs of various wind power plants in Denmark are discussed. Price lists for the plants are given along with prices for direct current generators for wind power plants.
 Author

597

ELECTRIC POWER FROM THE WIND
March 1945

6601
10

Percy H. Thomas

Federal Power Commission
Washington, D. C.

This monograph by Mr. Thomas on the general subject of power from the wind was prompted by the 1941-1945 construction and operation of a 1,000-kilowatt installation at Grandpa's Knob near Rutland, Vermont, on the system of the Central Vermont Public Service Corporation. This unit suffered a blade failure on March 26, 1945, and was abandoned because of economic considerations.

Mr. Thomas envisioned wind powered electric generation for use on interconnected utility networks, firmed up by hydroelectric storage facilities in order to overcome the firm power deficiencies of wind driven generators. Using certain economic data from the Grandpa's Knob operation, the author concluded that units of a size between 5,000 and 10,000 kilowatts were necessary for economic viability. The author described a twin-wheeled, two-bladed propeller design for a 7,500-kilowatt unit, and a twin-wheeled, three-bladed propeller design for a 6,500-kilowatt unit. In order to overcome in part the difficulty in coupling a variable speed, wind-driven mechanical source to a synchronous speed alternating current commercial system, the design included a wind-driven direct-current generator electrically coupled to a dc to ac synchronous converter. The author's calculated costs were \$68 per kilowatt of capacity for the 7,500-kilowatt unit, and \$75 per kilowatt for the 6,500-kilowatt unit.

Mr. Thomas concluded that, with certain assumptions, the economics warranted the collection of wind data in greater detail and specificity than that then accomplished, the testing of propeller designs in wind tunnels, and the construction of a full size (7,500 kW) prototype.

1942

1,000-kw WIND POWER ELECTRIC GENERATING PLANT.
Engineering, July 31, 1942, p.81-3.
Engineering, July 28, 1942, p.173. (Comment).

A description of the Smith-Putnam wind turbine
on Grandpa's Knob near Rutland, Vermont.

POWER FROM WIND.

Flight, May 21, 1942, p.508.

In a lecture recently given to the foreign and
colonial research group of the V.D.I. some interest-
ing details were revealed of the current research
on the exploitation of wind energy for industrial
purposes.

1942

N74-15757*# Scientific Translation Service. Santa Barbara,
Calif.
THE DIRECT DRIVING OF SYNCHRONOUS GENERATORS
BY LARGE SCALE WIND ELECTRICAL POWER GENERAT-
ING PLANTS IN PARALLEL OPERATION WITH A SYN-
CHRONIZING NETWORK. PART 1
Max Kloss Washington NASA Feb. 1974 27 p ref Transl.
into ENGLISH from Elektrotech. Z. (West Germany). v. 63, 13 Aug.
1942 p 362-367
(Contract NASw-2483)
(NASA-TT-F-15301) Avail: NTIS HC \$3.50 CSCL 10B

The damped eigen oscillation of a synchronous generator
connected with a fixed network is investigated. It is assumed
that the generator is driven by a wind propeller wheel. The
influence of the variation of the characteristic of the propeller
wheel on the variation of the transient oscillatory behavior is
investigated. First the wind velocity increase occurs suddenly
and then in a continuous fashion. The power control measures
including propeller pitch displacement are investigated for
preventing overloads on the generator. The danger of resonance
is pointed out. This depends on the number of propellers. The
question is discussed of whether it is better to use an asyn-

1942

N74-15765*# Kanner (Leo) Associates. Redwood City, Calif.
USING LARGE WIND POWER PLANTS TO DIRECTLY DRIVE
SYNCHRONOUS GENERATORS IN PARALLEL OPERATION
WITH A GOVERNING NETWORK
Max Kloss Washington NASA Feb. 1974 19 p Transl. into
ENGLISH from Elektrotech. Z. (West Germany). v. 63, 27 Aug.
1942 p 388-392
(Contract NASw-2481)
(NASA-TT-F-15343) Avail: NTIS HC \$3.00 CSCL 10B

Various aspects of wind powered synchronous generators
are described. The influence of the fan wheel characteristic on
damping of transients is slight. Altering vane position is the
only feasible method for regulating power in order to avoid
overloading the generator. In designing the fan wheel, and
choosing the number of vanes, the operating behavior of the
generator and the danger of resonance must be considered ahead
of efficiency. Practical operating characteristics of the fan wheel
must be known to the electrical engineer if he is to calculate
the course of events during a transient. Author

N74-15763*# Kanner (Leo) Associates. Redwood City, Calif.
PROGRESS IN THE UTILIZATION OF WIND POWER
G. W. Meyer Washington NASA Feb. 1974 14 p refs
Transl. into ENGLISH from Elektrizitaetsverwertung (Switzerland).
v. 18, no. 6/7, Sep-Oct. 1941/42 p 109-113
(Contract NASw-2481)
(NASA-TT-F-15346) Avail: NTIS HC \$3.00 CSCL 10B

Wind power continues to be of interest as a source of energy
for isolated locations. In order to distribute the capital costs
over many service hours, the wind motors should be able to
exploit low wind speeds. Low speed wind motors can be used
only for driving slow machinery. High speed wind motors to
drive small dynamos are now available which are self starting
at low wind speeds. Large scale wind power stations have not
yet passed the experimental stage. Author

N74-15768*# Kanner (Leo) Associates. Redwood City, Calif.
THE IMPORTANCE OF AND PROGRESS IN THE UTILIZA-
TION OF WIND POWER IN DENMARK
Dimitry Stein Washington NASA Feb. 1974 17 p refs
Transl. into ENGLISH from Elektrizitaetswirtschaft (Germany).
v. 41, no. 15, 5 Aug. 1942 p 346-349
(Contract NASw-2481)
(NASA-TT-F-15333) Avail: NTIS HC \$3.00 CSCL 10B

Denmark was one of the first countries to turn its attention
to generating electric energy from wind power, because it has
to import all oil and coal it uses, and it has virtually no hydroelectric
power. A large number of wind power stations were built in
the early years of World War I when fuel was scarce. The total
production of wind power was estimated at approximately 1.8
million kWh in 1941. The installation of wind power stations
was generally considered to be a temporary measure. Author

533

N74-15761* # Kanner (Leo) Associates, Redwood City, Calif.
AIR POWER PLANTS IN RUSSIA AND THE UNITED STATES
 (FROM DIMITRY STEIN, ELEKTRIZITAETSWIRTSCH.,
VOLUME 40, NO. 16, 1941)
 Washington NASA Feb. 1974 5 p Transl. into ENGLISH
 from Bull. Assoc. Swiss Electriciens (Zurich), v.33, no. 1, 1942
 p 17-18
 (Contract NASw-2481)
 (NASA-TT-F-15338) Avail: NTIS HC \$3.00 CSCL 10A

Various types of wind power plants in the USSR and in the USA are discussed. The VIME D-12 in Crimea, a large power plant, is described. Uses mentioned for the USA are running farm machinery, protecting pipes from corrosion due to leakage currents, and supplying power to amplifiers for telephone wires.
 Author

N74-15762* # Kanner (Leo) Associates, Redwood City, Calif.
UTILIZATION OF WIND POWER IN AGRICULTURE IN THE USSR

D. Stein Washington NASA Feb. 1974 13 p refs Transl.
 into ENGLISH from Elektrizitaetswirtschaft (West Germany), v. 40,
 no. 4, 5 Feb. 1941 p 54-56
 (Contract NASw-2481)
 (NASA-TT-F-15345) Avail: NTIS HC \$3.00 CSCL 10B

Wind motors are being used in Russian agriculture for milling and pumping water. Plans call for rapid expansion of the utilization of such power plants. The extent of present utilization, problems, and forecasts are outlined.
 Author

N74-20701* # Techtran Corp., Glen Burnie, Md.
PLANES OF DEVELOPMENT OF RURAL WIND POWER PLANTS

K. I. Shenfer and A. A. Ivanov Washington NASA May 1974
 7 p refs Transl. into ENGLISH from Elektrichestvo (USSR),
 no. 5, May 1941 p 21-22
 (Contract NASw-2485)

(NASA-TT-F-15513) Avail: NTIS HC \$4.00 CSCL 10A

The use of wind power plants for rural electrification is discussed. The application of various alternative power supply systems involving wind power plants is examined, and the advantages and disadvantages of each alternative are presented.
 Author

SMITH-PUTNAM WIND TURBINE.

Mech. Eng., June 1941, p.473-74.

N74-15756* # Techtran Corp., Glen Burnie, Md.
UTILIZATION OF WIND POWER
 J. W. VanHeys Washington NASA Feb. 1974 11 p refs
 Transl. into ENGLISH from Elektrotech. Z. (Berlin), v. 64, no. 34,
 22 Aug. 1940 p 787-790
 (Contract NASw-2485)
 (NASA-TT-F-15300) Avail: NTIS HC \$3.00 CSCL 10B

The possible power of wind in a wind turbine is determined. From available wind measurements the wind frequency line is plotted to provide the basis for the design of a wind turbine. Favorable results are not obtained if work is continued on the previous principle of mill construction. There are only two ways of achieving adequate power: enlarging the circumference described by the vane and utilizing higher wind velocities. The latter are present at an altitude of about 200 meters above the ground. Satisfactory performance is attained with a vane length of 60 meters. Thus it is recommended that tests running at least one year be instituted with these dimensions.
 Author

N74-17786* # Linguistic Systems, Inc., Cambridge, Mass.
DC GENERATOR FOR KOLKHOZ WIND POWERED GENERATORS

K. I. Shenfer and A. Ivanov Washington NASA Mar. 1974
 11 p refs Transl. into ENGLISH from Elektrichestvo (USSR),
 v. 61, 1940 p 14-16
 (Contract NASw-2482)
 (NASA-TT-F-15347) Avail: NTIS HC \$4.00 CSCL 10A

The use of carbonundum-graphite resistors to control the voltage output from small wind-powered generators is described. Experiments were performed for devising methods of regulating dc generators to supply constant voltage, and a new type of nonlinear resistor was developed for use as a regulator. Author

N73-30976* # Kanner (Leo) Associates, Redwood City, Calif.
PROJECT OF WIND MOTOR WITH AERODYNAMIC TRANSMISSION FOR CAPACITIES OF 100 kw TO 3000 kw

N. V. Krasovskiy Washington NASA Sep. 1973 21 p refs
 Transl. into ENGLISH from Izv. Ord. Tekh. Nauk, Akad. Nauk
 SSSR (USSR), no. 5, 1939 p 66-77
 (Contract NASw-2481)
 (NASA-TT-F-15131) Avail: NTIS HC \$3.25 CSCL 10A

To reduce excessive weight requirements in the design of a 100-3000 kw capacity wind motor, aerodynamic transmission is employed. Aerodynamic transmission involves mounting secondary small windmills at the ends of the main wheel blades of the wind motor. The secondary small windmills operate in a high-velocity stream of 40-70 m/sec and can produce energy directly from the wind with the windmills turning at 500 or more rpm, with an efficiency of 80 percent or higher. Author

N74-15741*# Scientific Translation Service, Santa Barbara, Calif.

ECONOMY AND PRACTICAL APPLICATIONS OF LARGE WIND-DRIVEN POWER PLANTS. PART 1

H. Witte Washington NASA Feb. 1974 14 p refs. Transl. into ENGLISH from Elektrotech. Z. (Berlin), v. 59, no. 51, 22 Dec. 1938 p 1373-1376

(Contract NASw-2483)

(NASA-TT-F-15308) Avail: NTIS HC \$3.00 CSCL 10A

The question of the economy of large scale wind electrical generating stations is investigated based on present findings. By exploiting wind energy for producing electrical power, large amounts of coal could be made available for other uses, and would also ease our foreign currency situation. The practical aspects of large scale wind electrical power generating plants are discussed. The construction of a ring generator is described.

Author

N74-16802*# Scientific Translation Service, Santa Barbara, Calif.

THE ECONOMY AND PRACTICALITY OF LARGE SCALE WIND GENERATION STATIONS (CONCLUSION)

H. Witte Washington NASA Feb. 1974 15 p refs. Transl. into ENGLISH from Elektrotech. Z. (Berlin-Charlottenburg), v. 59, no. 52, 29 Dec. 1938 p 1404-1407

(Contract NASw-2483)

(NASA-TT-F-15348) Avail: NTIS HC \$4.00 CSCL 10B

The design and operational problems of wind power generating stations are discussed. Wind power generating stations are found to be economical for operation in conjunction with existing generating stations. Very large ring generator stations are described.

Author

N74-15743*# Kanner (Leo) Associates, Redwood City, Calif.

WIND POWER PLANTS IN RUSSIA

Th. Sauer Washington NASA Feb. 1974 7 p refs. Transl. into ENGLISH from VDI (Ver. Deut. Ing.) Z. (West Germany), v. 81, no. 32, 7 Aug. 1937 p 947-948

(Contract NASw-2481)

(NASA-TT-F-15331) Avail: NTIS HC \$3.00 CSCL 10B

Several measures relative to wind power plants have been taken by the Soviet government, and are outlined. The large Balaklava wind power plant is described briefly. The wind power experimental facility in Moscow is illustrated in a diagram and its operation discussed in some detail.

Author

PROPELLER DESIGN AS APPLIED TO WINDMILLS.

E.N. Fales.

J. Aero. Sci., June 1936, p.278-81.

1935

THE EXTRACTION OF ENERGY FROM THE WIND.

E.A. Stalker.

J. Aero. Sciences, July 1935, p.162-167.

Available power from the wind for a wind power plant employing wings moving parallel to themselves along a closed path. Efficiency compared with that of rotating cylinders.

1934

Tests of models of a windmill. By A.G.von Baumhauer.
Report A.258, p. 28-33 incl. tabs.& 3 figs.

(diagrams. & curves)

Experiments with three models of windmill sails.

By A. Havinga.

Report A.269, p. 35-45 incl. 10 tabs! & 6 figs.
(diagram, photo. & curves)

see

Report of the Rijks-Studiedienst voor de Luchtvaart, Amsterdam, for the yr. 1934, Vol. 7, (Dutch text with summaries in English, German & French text).

6510

RSL/1934
(Holland)

N73-24268*# Scientific Translation Service, Santa Barbara, Calif.
THE FIRST AERODYNAMIC THREE-PHASE ELECTRIC POWER PLANT IN BALAKLAWA
 W. R. Sektarov Washington NASA Jun. 1973 13 p Transl.
 into ENGLISH from L'Elettrotecnica (Italy), v. 21, no. 23-24,
 Aug. 1934 p 538-542
 (Contract NASw-2483)

NTIS HC \$3.00 CSCL 10B
 (NASA-TT-F-14933) Avail: NTIS
 The assembly and functional characteristics of an experimental
 100 kW power plant built in Crimea are described. The operating
 data obtained during the first two years of operation are
 reported. Author

The present state of planning and erection of large
 experimental wind-power stations. Kanner (Leo)
 Associates, Redwood City, Calif. SEXTOROV, V. R.
 Washington NASA APR. 1974 15 PAGES
 Transl. into ENGLISH from Elektricheskoe (Moscow),
 no. 2, 1933 p 9-13 NASA-TT-F-15512 AVAIL-

NTIS HC \$4.00
 *ENERGY CONVERSION, *WINDPOWER UTILIZATION, *WINDPOWERED
 GENERATORS
 ECONOMIC FACTORS, ELECTRIC POWER SUPPLIES, ENERGY SOURCES,
 U.S.S.R. C03 87a-21678*6

NACA TN-474

WINDMILLS IN THE LIGHT OF MODERN RESEARCH.

A. Betz. Aug. 1928 27p. 9 fig.

A NEW PROPELLER-TYPE, HIGH-SPEED WINDMILL FOR ELECTRIC
 GENERATION. PART 1. WINDMILL DESIGN. PART 2. STUDY
 OF AVAILABLE ENERGY IN THE WIND AND SELECTION OF
 SUITABLE WINDMILL DIAMETER FOR BEST UTILIZATION OF
 THIS ENERGY.

E.N. Fales.

Aeronautics, v.50, no.6, Jan.-Apr. 1928, AER-6.

MECHANICAL ENGINEERING

Volume 53

May, 1931

No. 5

p.p. 333-38.

The S-Rotor and Its Applications

A Bi-Vane Power Wheel of S-Shaped Cross-Section Working in Wind or Water, and Its Appli-
 cation in Pumping, Electric-Current Generation, and Ventilation, and as a Current and
 Wave Motor Where Moderate Amounts of Power Are Required

602

By S. J. SAVONIUS,¹ HELSINGFORS, FINLAND

1927

A NEW PROPELLER-TYPE, HIGH-SPEED WINDMILL FOR
ELECTRIC GENERATION. E.N. Fales.
Mech. Engineering, Dec.1927, p.1309-1311.
A.S.M.E. Trans., Apr.1928, p.1-16.
(with discussion)

CN-124,181 (1925)
A FURTHER APPLICATION OF THE MAGNUS EFFECT TO
WINDMILLS AND TO BOAT PROPULSION. Alexander Klemin.

Mechanical Engineering,
p.911-912 Nov.
1925

Rotors, Wing - Savonius

1923

POWER FROM THE WIND.
Scientific American, Feb.1926, p.1114-1115.

Aerodynamic
Savonius wind-motor
Montana windmill

NACA TN-164

GENERAL THEORY OF WINDMILLS.
M.M. Munk. Oct.1923. 5pp. & 2figs.

LATE ADDITIONS

N74-21682* # Kanner (Leo) Associates, Redwood City, Calif.
WIND ELECTRIC POWER STATION
Hermann Honnef Washington NASA Apr. 1974 14 p Transl.
into ENGLISH from German Patent no. 871580/23 Mar. 1953)
(Contract NASw-2481)
(NASA-TT-F-15522) Avail: NTIS HC \$4.00 CSCL 10A

A wind power station is described in which the structure on which the rotors are mounted may tilt as wind speed changes so that the rotors leave the vertical plane to anticipate increased wind speeds. The power station may have pulse generators located in front of the turbine rotors on extensions of the turbine shaft or on separated booms under the turbine; winches to tilt the turbine platform, normally locked by means of a brake, which is released when a predetermined wind thrust is reached; flexible tension members to transmit the thrust of the wind to the nonlifting portion of the structure; provisions to change the direction of the winches as wind speed changes; an auxiliary vane to control an electrically driven propeller to rotate the power plant into the wind; and auxiliary generators to be used when wind speeds are too low for normal synchronous operation. Author

N74-21677* # Scientific Translation Service, Santa Barbara, Calif.

WIND POWER TURBOGENERATOR FOR HIGH ALTITUDE WIND UTILIZATION

H. Honnef Washington NASA Apr. 1974 12 p Transl. into ENGLISH from German patent no. 885284/3 Aug. 1953) 4 p (Contract NASw-2483)
(NASA-TT-F-15455) Avail: NTIS HC \$4.00 CSCL 10A

A windpowered electrical generator is reported that consists of two counter-rotating wheels, one being the armature and the other being the field. Means of compensating for varying wind speed are described. Author

N74-20700* # Kanner (Leo) Associates, Redwood City, Calif.
**SUPPLEMENT TO THE REPORT ON THE RESULTS
ACHIEVED WITH SEAS' EXPERIMENTAL MILL**

J. Juul Washington NASA Apr. 1974 40 p refs Transl.
into ENGLISH from Elektrotekniker (Copenhagen), v. 48, Feb. 1952 p 65-79
(Contract NASw-2481)
(NASA-TT-F-15516) Avail: NTIS HC \$5.00 CSCL 10A

Results achieved with an experimental windmill are elaborated on: greatest efficiency of the mill was obtained at a wingtip velocity of 38 m/x; effects caused by wind pressure should not exceed 800 kg/sq cm in any part of the wing or tower, and effects caused by gravity in the wings should not exceed 200-300 kg/sq cm. Experience has shown that the optimal height of the support tower should be from 18-24 m. A history of the Dutch windmill's use and its construction, and also of various modern experimental wind power stations in various parts of the world is given. Costs of building wind power stations are discussed. Author

N74-22708* # Kanner (Leo) Associates, Redwood City, Calif.
**STATISTICAL SUMMARY AND EVALUATION OF VENTO-
ELECTRIC POWER STATION OUTPUT (PART 2 OF 2)**
D. R. Stein Washington NASA Jun. 1974 16 p refs Transl.
into ENGLISH from Elektrizitaetswirtschaft (Frankfurt am Main), v. 50, no. 11, Nov. 1951 p 325-329
(Contract NASw-2481)
(NASA-TT-F-15652) Avail: NTIS HC \$4.00 CSCL 10A

Data obtained from the operation of windmills in Denmark were used to study the performance of several sizes and designs. Tabulated information shows: (1) how performance is affected by wind velocity patterns, particularly mean velocities; by rotor diameter, and by how the output is used; (2) what fraction of available wind is utilized; (3) how regularly or irregularly output varies with time; (4) what peak values occur; (5) the duration of lulls; and (6) how utilization time depends upon the power level used as a reference. Author

N74-21679* # Kanner (Leo) Associates, Redwood City, Calif.
**STUDIES OF THE UTILIZATION OF WIND ENERGY: THE
USE OF dc GENERATOR/MERCURY-VAPOR INVERTER
SETS CONNECTED TO dc NETWORKS**

Antonino Asta Washington NASA Apr. 1974 14 p refs
Transl. into ENGLISH from Ric. Sci. (Rome), no. 1-2, Jan. Feb. 1950 p 53-59
(Contract NASw-2481)
(NASA-TT-F-15514) Avail: NTIS HC \$4.00 CSCL 10C

Different types of electrical generators are reviewed that can be used with wind energy. A set is described that is comprised of a generator supplied by a suitable type of excitation and a mercury-vapor inverter capable of incorporation in a three-phase network with constant voltage and frequency, provided with reservoirs, by a fixed-pitch air motor without a speed regulator. Experimental results obtained with such a set are reported. Author

N74-22703* # Techtran Corp., Glen Burnie, Md.
**THE MEASUREMENT OF LARGE WIND ENERGY GENERA-
TORS**

C. Martini Washington NASA May 1974 16 p Transl. into ENGLISH from Elektrotech. Maschinenbau (Austria), v. 57, no. 7/8, 17 Feb. 1939 p 83-89
(Contract NASw-2485)
(NASA-TT-F-15433) Avail: NTIS HC \$4.00 CSCL 10A

The weight comparison of energy generators according to the Honnef System is represented in curves wherein the weight is plotted as a function of three variables: the number of poles, air induction, and diameter. Author

N74-21678* # Kanner (Leo) Associates, Redwood City, Calif.
**THE PRESENT STATE OF PLANNING AND ERECTION OF
LARGE EXPERIMENTAL WIND-POWER STATIONS**
V. R. Sektorov Washington NASA Apr. 1974 15 p Transl.
into ENGLISH from Elektrichestvo (Moscow), no. 2, 1933 p 9-13
(Contract NASw-2481)
(NASA-TT-F-15512) Avail: NTIS HC \$4.00 CSCL 10A

An investigation into the use of wind-power stations, which are planned for the second 5-Year Plan is discussed. The size of stations planned is 5000 kW, and they are to be built in areas of the country where there is a sufficient annual wind speed to justify economic use. The Balaiskav experimental station was investigated and results show that it was economical, but new research must be done to improve overall performance. Author

N74-19709* # Scientific Translation Service, Santa Barbara, Calif.

HIGH WIND POWER PLANTS

H. Honnef Washington NASA Apr. 1974 19 p refs Transl.
into ENGLISH from Elektrotech. Maschinenbau (Berlin), v. 57, no. 41 and 42, 13 Oct. 1939 p 501-506
(Contract NASw-2483)
(NASA-TT-F-15444) Avail: NTIS HC \$4.00 CSCL 10A

In comparison to the usual power plants in which the machines are installed in special buildings, the high wind power plant is described as a power source in which the structure as a whole makes up the machine. New large structures are supports for generators with large diameters but with the other dimensions small. The use of the advantageous high wind flow leads to unusually high structures, but these are completely storm safe and stable, as well as economical. Details of the counter-rotating turbine and some experimental results are presented. Author

CO 4

1939

I. OCEAN/WATER

Energy from the Ocean: An Appraisal.

Owen M. Griffin.

Naval Research Lab Washington D C May 74, 47p NRL-

MR-2883

AD-779 877/OWE PC\$3.25/MF\$1.45

The oceans and their environment have long been envisioned as renewable sources of energy. It is the purpose of this report to assess the feasibility of drawing on the sea for power and to determine the extent to which the oceans are likely to serve future energy needs. A review is made of proposed U.S. funding levels for the research and development of renewable energy sources during the years 1975 - 1979, and a study is made of the technical and environmental acceptability status of tidal, wind, and sea thermal power generation systems. The estimated costs of these environmental power sources are compared with the prevailing power costs for nuclear and coal plants. On the basis of these comparisons, recommendations are made for a program of research and development, culminating in the construction of prototype plants, for wind and sea thermal power plants. Tidal power generation is found to be technically feasible but economically uninviting at present. (Author)

INVOLVING THE OCEANS IN SOLVING ENERGY PROBLEMS.

W.E. Shoupp, Westinghouse Electric. p.18-28.

ALTERNATE ENERGY SOURCES FROM THE OCEAN.

W.E. Heronemus, Mass. Univ., Amherst. p.35-38.

Mar. Tech. Soc. J., v.8, no.2, Feb.1974.

OSMOTIC PUMP. Levenspiel, O. (Oregon State Univ., Corvallis); de Nevers, N. Science, 183: No. 4121, 157-160(18 Jan 1974).

Descriptions are given of an osmotic pump that would produce fresh water from seawater at no expenditure of energy and an osmotic power plant that would extract energy from the ocean. The scientific basis of these devices and their prospects as engineering devices are analyzed. Three analyses are made in various cases: the equilibrium ocean, where the salt concentration and density change with depth; the uniform ocean, where the ratio of salt to water stays constant, but the density changes with depth; and the real ocean, which is neither at equilibrium nor uniform. (MCW)

Nature, v.249, June 21, 1974, p.720-724.

Wave power

S. H. Salter

Bionics Research Laboratory, University of Edinburgh, Edinburgh EH1 2QL, UK

Solar energy is one form of income on which we can afford to live. Here is another proposal: the use of power from the waves at sea.

1974

ENERGIEVERSORGUNG DURCH WEL-
LENGENERATOR. [Energy Supply by Wave Gener-
tor]. The possibility of using wave energy for the supply
of power to meteorological and oceanographic measur-
ing instruments located on buoys and thus replace
storage batteries or diesel-generator sets now in use is
outlined. The design of a hydroelectric wave generator
is presented briefly. 8 refs. In German with English
abstract.

Kayser, Harald. *Meeresforsch. Mar Tech* v 5 n 1 Feb 1974
p 29-31.

METHOD AND SYSTEM FOR CONVERSION OF WATER
AND DEVELOPMENT OF POWER. Hazcock; B. J.; Johnson,
D. E.; Merkley, Z. W. (to Aqualectric of Arizona). U. S. Patent
3,754,147. 21 Aug 1973. Filed date 18 Oct 1971. 13p.

Using the power from ocean waves, air is entrained by the
Bernoulli principle and placed under compression. This com-
pressed air is used to drive prime movers and to generate
electricity. The generated electricity can be employed to desalt
and separate sea water electrolytically into oxygen and hydrogen,
and the gases can then be used to produce power and other useful
products. The hydrogen that is highly fluid and of low weight can
be transported inexpensively to a distance from the sea and then
reconverted to water, combining it with atmospheric oxygen, pro-
ducing substantial energy as well as water. (Official Gazette)

1973

S-435

GULF STREAM FLOW SEEN AS A POWER SOURCE.
Comm. Today, v.3, p.27,28, JL,9,1973.

607

THE OCEAN AS A POWER RESOURCE.

J.D. Isaacs and R.J. Seymour.

Int. J. Environmental Studies, v.4, no.3,
Mar.1973, p.201-205.

This paper considers the feasibility of trapping a number of potential sources of energy in the oceans, assesses their magnitude in relationship to projected world needs, and discusses some means for avoiding environmental degradation.

CONVERSION SYSTEM FOR PROVIDING USEFUL ENERGY FROM WATER SURFACE MOTION. Richeson, D. T. US Patent 3,758,788. 11 Sep 1973. Filed date 14 Jun 1971.

An energy-conversion system is disclosed for converting water surface movement, e.g. wave motion, to useful energy. Buoyant structures are provided defining pairs of opposed surfaces affixed together by pivotal structures with energy means, e.g. bellows, held spaced-apart from the pivot means. In the disclosed embodiment, the bellows are actuated with displacements between the buoyant structures, to develop positive fluid pressures to accomplish various operations. As disclosed, a turbine is driven to motivate an electrical generator for providing electrical power through a conductor to an electrical load. (auth)

Windmills for water

Large, slow underwater machines like windmills could be a promising source of fuel-free, nonpolluting electric power in the Gulf Stream off the Miami coast, suggests John R. Apel of the National Oceanic and Atmospheric Administration's laboratory on Virginia Key, Fla.

An optimum spot would be the Straits of Florida which pass between Miami and the island of Bimini, where the flow of the current is channeled and steady, varying by only about 20 percent above or below normal, reports Apel together with William S. von Arx and Harris B. Stewart Jr. of the Woods Hole Oceanographic Institution.

About 0.8 kilowatts of power per square meter could be obtained from the upper levels of the current, the researchers estimate. This would be an improvement over the 0.22 kilowatts available from sunlight over Miami, says Apel, which would be reduced another 75 percent by the inefficiency of solar cells. SCIENCE NEWS Y.103, P. 272

71-0E-000

Whitehead, P.L. Sr.
Cecil, N.A.

See Wave Electric Power System.

pp. 159-160. 1971.

Engineering in the Ocean Environment. Conference. Record. (Held in San Diego, Calif., Sept. 21-24, 1971). Sponsored by Institute of Electrical and Electronic Engineers. Oceanography Coordinating Committee, New York City. pp. 6-8. 1971.

Abs.. 1 fig., no refs., from AA.

POWER GENERATION : TURBINES : WAVE ENERGY : Sea Wave Electric Power System.

See Wave Electric Power System (SWEPS) is a new method of combining sea wave power and air driven turbines to generate electrical energy by using sea wave power to compress air to high pressure and using that air to drive a high speed air operated turbogenerator. The idea, primarily conceived to furnish power for Sea Relay and Weather Towers, might be modified for use to generate power for commercial consumption by mounting the apparatus on a floating pier or buoy supported platform.

Concept for a self-contained oceanic resource base.

Marine Technology Society. Journal, 4(6) :88-102, Sept.-Oct. 1970. Abs., 20 figs., 4 tables, 66 refs. (2 in Czech, 2 in Fr.), from AA.

CROMWELL CURRENT : OCEAN FLOOR STATIONS : OCEAN RESOURCES : POWER GENERATION : TURBINES : Oceanic Resources Base.

Modified low-head turbines (energized by the Cromwell Current) could perhaps raise deep nutrient-rich waters and possibly fine sediments to the surface, forming artificial fishing "banks." An intensified jet-siphon unit driven by a turbine pump could conceivably raise coarse sediments and manganese nodules. The pelagic sediments could be "harvested" and barged to a nearby oceanic resources base and processed as a source of soil, minerals, and evaporites. Turbine energy would possibly be available for conversion of seawater to fresh water and for communication or power to South American countries.

Harnessing energies of oceans--1; R.H.CHARLIER; Mar Technology Soc J v 3 n 3 May 1969 p 13-32; The development of the use of tidal power is surveyed from classical times to the completion of the Rance-River plant. The choice of sites, construction and operation of the French plant, and the major sites for tidal-power plants throughout the world are examined.

Harnessing energies of oceans--2; R.H.CHARLIER; Mar Technology Soc J v 3 n 4 July 1969 p 59-81; Tidal power projects around the world are surveyed, with emphasis on Great Britain, Argentina, Soviet Union and Australia. Advantages and disadvantages of tidal power plants are considered from the viewpoint of economics and interaction with the surroundings. Other sources of energy from the ocean are mentioned, including electroosmosis, waves, ocean currents, upwellings, thermic energy, fresh-and-salt-water contact and salinity exchanges. Bibliography.

608

1972

P. 272

SCIENCE NEWS Y.103,

P. 272

1956

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CN-75179

POSSIBILITY OF HARNESSING THE ENERGY OF SEA CURRENTS BY MEANS OF DEVICES SIMILAR TO AIR-DRIVEN GENERATORS. (Sur la possibilité d'utiliser l'énergie des courants marins au moyen de machines analogues aux aérogénérateurs). G(astron) Remenieras and P. Smaghe. (Presented at 4th Hydraulics Conf., Paris, June 13-15, 1956). (Fr. text & Eng. summary).

Ocean currents

Generators

Power sources, Ocean

Hydraulics Conference, June 13-15, 1956
Proceedings, p.532-539

The respective characteristics of a given propeller when driven by air and water are compared, taking similarity laws applicable in fluid mechanics into account. Calculates the leading dimensions of a sea current-driven electric generator designed along the same lines as well established aero-generators. Also contains a calculation of the annual energy available at some of the sites for which adequate measurements are available.

1971

Japan Defense Agency, Technical Research Agency

Wave activated generator for robot weather buoy and other use.
18 pages. March 1971.

CNEXO, Centre Oceanologique de Bretagne, Groupe Scientifique, Brest, Fr.
Utilisation de la maregraphie au large pour la prise de possession du plateau continental et pour l'étude de la dynamique océanique.
Colloque International sur l'Exploitation des Océans. Theme V, Vol. 1 Proceedings. (Held in Bordeaux, Fr., March 1971). Centre National pour l'Exploitation des Océans, Paris. 3 pages. March 1971.

In English; Fr. sum., illus., no refs., from Text
GENERATORS : WAVE ENERGY : METEOROLOGICAL BUOYS :
INSTRUMENT DESIGN : JAPAN : wave-activated generator.

A wave-activated generator is described which transforms wave energy into electrical tube, the immersed extremity of which is open. In Japan, 200 such generators are used with buoys or lighthouses. An oceanographic automatic weather buoy with a wave-activated generator weighing about 1.2 tn (including to anchoring equipment), transmits measurements of wave height, air and water temperature, wind direction and velocity, and noise to a coastal station 20 km away. The buoy is equipped with a Ni-Cd battery for 80 amp-hr, 24 V, and a telemeter. This generator is well adapted to buoys and automatic stations; it may also be applied to lander stations.

1966

GC2.T329 v.3

TERRY, R. D., ED.

Ocean engineering, vol. III, Part 1,
Energy sources and energy conversion,
Waste conversion and disposal; Part 2,
Undersea construction, habitation, and
vehicles; Recreation. North Hollywood,
Calif., Western Periodicals, 1966.

GC2.T329 v.3
2 in 1 v.

N-140,495 National Science Foundation
NSF GI-39114

SOLAR SEA POWER. (Semi-annual Progress report,
Nov.1,1973-Jan.31,1974). (Prepared by Carnegie-
Mellon U.). Jan.25,1974.

ABSTRACT: In this semi-annual (second quarterly) report a conceptual design is developed which in no way depends upon ocean currents, and in which all physical processes are well understood. Contamination of the input water to the boiler by the output water is avoided by taking advantage of the naturally occurring density stratification, at least for plants which do not exceed 700,000 kilowatts. High density power generation without moisture, and the consequent power expenditure in its removal, is obtained by falling film evaporation on vertical tubes. Appreciable pressure drop in the large banks of vertical tubes in the evaporator and condenser is avoided by proper manifolding. We have demonstrated our optimization scheme to be capable of handling 30 variables and 20 constraints within a compilation and running computer time less than a minute. This scheme gives not only the minimum cost and the optimizing values of the variables, but also all sensitivity coefficients. (Auth)

OCEAN ENERGY: NEW LIFE FOR AN OLD IDEA.
Science News, v.105, June 15,1974, p.381-82.

Thermal power plants making use of the differences between warm surface water and cold deep water.

THERMAL ENERGY FROM THE OCEAN DEEPS.

Lavi, A. and Zener, C. (Carnegie Mellon Univ.,
Pittsburgh, Pa.)

Elettrotecnica, v.61, no.2, Feb.1974, p.95-100.

NEW EXOTIC ENERGY IDEA: SOLAR POWER FROM THE SEA. Elec. Light Power, E/G Ed.; 52: No. 5, 17-18(Mar 1974).

The solar power project aimed at generating electric power using ocean water temperature differences as an energy source is being funded primarily by NSF's RANN program. Electricity is generated by boiling a fluid at the temperature of water near the surface, then expanding the gas through turbine to drive a generator, then condensing the gas at the temperature of cold water from the depths. The sun, warming the surface water, is the free source; there is no fuel cost. The seapower plant is not affected by nighttime or cloud cover and the temperature difference remains constant, eliminating the need for energy storage. Due to a temperature difference of about 20°C, the thermal efficiency is only about 3 per cent. Schematics of the closed-cycle ocean thermal power plant and the Mark I prototype solar sea power plant are shown. (MCCW)

N-140,494 National Science Foundation
NSF-GI-39114

SOLAR SEA POWER. (QPR 1 June 1-Sept.30,1973).
(Prepared by Carnegie-Mellon U.). Oct.11,1973.

N-140,493 National Science Foundation
Conference on Solar Sea June 27-28, 1973
Power Plant

PROCEEDINGS, SOLAR SEA POWER PLANT CONFERENCE AND
WORKSHOP, June 27-28, 1973. Abraham Lavi, ed.
(Held at Carnegie Mellon U., Pittsburgh, Pa.).
June 1973. PB 228-066

ABSTRACT: A national conference was convened at Carnegie-Mellon University in Pittsburgh, Pennsylvania for discussions on ocean thermal energy conversion. The conference was sponsored by the National Science Foundation and organized by Carnegie-Mellon University. Its objectives were to afford an opportunity for information exchange, identification of key problems, and for discussions of how to implement the ocean solar power plant technology. Key workers and researchers were brought together, they first reported on existing studies as to technology and design problems of ocean thermal energy conversion. The edited versions of the formal presentations are contained in these proceedings. Following these presentations, six working groups were convened, for discussions on technological and environmental aspects of the subject. Summaries of the working groups' outputs are presented for the following topics: power plant siting, economic and political problems, environmental considerations; low temperature gradient heat transfer; turbines and fluids; plant anchoring; cold water pipe design. (AUTH)
AVAILABILITY: NTIS. PB 228 066 (\$6.75 paper copy/\$1.45 microfiche)

TITLE: Drainage Systems for Condensation
AUTHOR: Zener, C.; Lavi, A.
CORPORATE AUTHOR: Carnegie-Mellon University
ADDRESS: Pittsburgh, PA
PUBLICATION DESCRIPTION: Report No.
NSF/RANN/SE/GI-36979/TR73/1, 36 p.
PUBLICATION DATE: 1973
SPONSOR: National Science Foundation, RANN Program
ABSTRACT: Efficient condensing surfaces are highly desirable in the design of solar sea power plants utilizing the ocean temperature difference. This paper examines a number of surface designs and presents a convenient method for optimizing the design. (Auth)

TITLE: Initial Investigation of Boiler and Condenser Tube Designs
AUTHOR: Connell, J.W.; McGowan, J.G.
CORPORATE AUTHOR: University of Massachusetts, Mechanical Engineering Dept.
ADDRESS: Amherst, MA
PUBLICATION DESCRIPTION: Report No.
NSF/RANN/SE/GI-36979/TR73/4, 35 p.
PUBLICATION DATE: 1973, June
SPONSOR: National Science Foundation, RANN Program
ABSTRACT: This report points out the importance of boiler and condenser heat exchanger designs for ocean thermal power plants. The assumptions used to formulate the heat exchanger models are listed, and the analytical results are presented of an initial investigation of condenser and boiler tubes using ammonia or propane. It was found that ammonia has significantly better heat transfer characteristics for both the condensing and boiling processes, but ammonia may not be the better fluid because its latent heat of evaporation is 3.5 times greater than that of propane. The operating range of flow rates for various practical tube sizes for ammonia and propane is provided. (NPG)

TITLE: Turbine Design: Sea Solar Power Plants
AUTHOR: Anderson, J.W.
CORPORATE AUTHOR: University of Massachusetts, Energy Program
ADDRESS: Amherst, MA
PUBLICATION DESCRIPTION: Report No.
NSF/RANN/SE/GI-36979/TR73/7, 22 p.
PUBLICATION DATE: 1973, June
SPONSOR: National Science Foundation, RANN Program
ABSTRACT: The low temperature differences between the heat sources and the heat sink in a Sea Thermal Power Plant affect the turbine design requirements. The design problems are more similar to those of water turbines than those of steam or combustion gas turbines. Turbine size and speed and design characteristics are discussed. Vapor turbines for sea thermal plants combine the good features of many other turbines and should be capable of higher efficiency and lower cost than turbines for almost any other type of power plant. (NPG)

1973

SOLAR SEA POWER.

C. Zener.

Physics Today, Jan. 1973, p. 48-53.

Heat engines operating in the tropical oceans, capitalizing on the temperature differential between upper and lower levels, could provide a source of economical, pollution-free electricity.

Sea solar power, the promise and the problems. J.H. Anderson. EASCON '73. Record. Washington, D.C., USA, 17-19 Sept. 1973 (New York, USA: IEEE 1973), p. 107-12.

The author describes how vast amounts of power can be generated from the sun warmed ocean waters in conjunction with the cold waters underneath. The potential supply of power and economics are compared to other possible sources of energy. The various legal, environmental, technical and economic problems are discussed, with suggestions for required development programs. The conclusions are that Sea Solar Power can be economically practical in a short time with a rather small development program compared to its huge potential. (1 refs.)

Amer. Geophys. Union, 54 h
Ann. Meeting, Apr. 16-20, 1973,
Wash., D.C.

US (Invited Paper; 30 min)
J. Hilbert Anderson
Consulting Engineer
1615 Hillock Lane
York, Pa. 17403

The Potential for Solar Sea Power Generation. Vast amounts of power can be generated at low cost by utilizing the upper sun heated surface layers of water in the tropical oceans to boil a high pressure fluid such as propane. The propane is expanded through a turbine to produce power, then condensed at low pressure by cold water pumped from deep in the ocean. The warm water discharged from the power plant can then be degassed and partially evaporated to produce fresh water condensed by the cool water discharged from the propane condensers. The potential quantities of power that can be generated from the Gulf Stream and the Caribbean Sea are enormous. Some estimates of their magnitude will be given. Preliminary estimates of effects on the natural heat balance will be given, as well as some discussion of possible effects on the marine ecology.

POWER, FRESH WATER, AND FOOD FROM COOL, DEEP SEA WATER. Othmer, D. F.; Roels, O. A. Science; 182: No. 4108, 121-125/12 Oct 1973.

Solar heat energy accumulates in the vast volume of warm tropic seas. The looming energy crisis causes a renewal of interest in utilizing this stored solar heat to give, in addition to electric power, vast quantities of fresh water. Warm surfaces, when evaporated, generate steam, to power a turbine, then fresh water when the steam is condensed by the cold water. A great increase in revenues over that from power and fresh water is shown by a substantial mariculture pilot plant. Deep seawater contains large quantities of nutrients. These feed algae that feed shellfish, ultimately shrimps and lobsters, in shallow ponds. Wastes grow seaweed of value; and combined revenues from desalination, power generation, and mariculture will give substantial profit. (auth)

PLUMBING THE OCEAN DEPTHS: A NEW SOURCE OF POWER. Lavi, A.; Zener, C. (Carnegie-Mellon Univ., Pittsburgh). IEEE (Inst. Elec. Electron. Eng.), Spectrum; 10: No. 10, 22-27/Oct 1973.

The main difficulty in harnessing solar energy is collecting it. The collection mechanism for solar sea power is the ocean. Solar energy, absorbed by the surface waters of tropical oceans, can be converted first into electric power by solar sea power plants, then converted by electrolysis into chemical energy, and transported by ship for distribution to heat homes, power transportation facilities, and form a basic ingredient in materials processing. The problems involved for a SSPP are insufficient temperature difference, corrosiveness of sea water, microbial fouling, plant anchoring, diluteness of solar energy in the ocean, and environmental effects. (MCW)

OCEAN THERMAL DIFFERENCE POWER-PLANT DESIGN. Paper discusses the preliminary design of a closed Rankine cycle power system using the ocean temperature difference as an energy source. A thermal cycle analysis and hull design factors for the system are presented. Graphical and tabular results which illustrate the importance of various cycle and design parameters are included as well as the outline of the digital-computer-based cycle analytical model. In addition, one design for a 400-mw power plant is shown. 27 refs.

McGowan, J.G. Univ of Mass, Amherst; Heronemus, W.E.; Connell, J.W.; Cloutier, P.D. ASME Pap n 73-WA/OCT-5 for Meet Nov 11-15 1973 11 p.

1973

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Intersociety Energy Conversion Engineering Conference, 8th Philadelphia, Pa., 1973.
Proceedings. New York, American Institute of Aeronautics and Astronautics [1973]
847 p. illus. 29 cm.
Held at: University of Pennsylvania, Philadelphia, Pa., August 13-16, 1973.
Sponsored by: American Institute of Aeronautics and Astronautics [and others]

Conceptual Design of a Rankine Cycle Powered by the Ocean Thermal Difference - J. G. McGOWAN, J. W. CONNELL, L. L. AMBS, W. P. GOSS.. 420

1973

THE SEA PLANT-A SOURCE OF POWER, WATER, AND FOOD WITHOUT POLLUTION.

Anderson, J. H.

Solar Energy, v.14, 1973, p.287-300.

Abstract - This article expands the idea of sea thermal power to show how it can be used to produce fresh water as a by-product or a major product from the plant. Limitless quantities of fresh water can be produced at a cost of less than five cents per thousand gallons.

The warm water leaving the boilers of the power plant is deaerated, then boiled under vacuum conditions to produce steam. The heat to evaporate steam comes from the water and lowers its temperature a few degrees.

The steam is condensed in condensers cooled by the cold water discharged from the power plant condensers. The power required for pumping the water and for deaeration is produced by the sea thermal power plant. More than a billion gallons of water per day can be produced by a power plant of 100 MW capacity.

Since the condenser water from the deep ocean is warmed by the power plant and desalting plant, it will remain near the surface, and can therefore provide food for fish. We estimate that a 100 MW power plant can supply enough nutrient-rich water to grow up to seven million kilograms of fish per year.

Research Applied to Ocean Sited Power Plants.

J. Hilbert Anderson.
Massachusetts Univ., Amherst. 31 Jul 73, 67p NSF-RAN/N-73-056 NSF-RANN/SE/GI-34979-73-2
PB-228 878/5WE PC\$6.50/MF\$1.45

Additional subsystem and component sizes were produced for the Ocean Thermal Power Plant. The math model of the cycle calculates effects from single or group parameter variations. Results are given in terms such as overall thermal efficiency, size and cost. Efficiencies close to 2.0% are indicated for a 32F (delta t). Three working fluids remain competitors. One Total System Configuration is in use as a common denominator for all research effort; other configurations are under study. Prospects for economic thermal plants look very good. Solutions to remaining major problems appear to be state-of-art. One 1100 mWe submerged nuclear power plant has been arranged and balanced. The condenser exhaust plume has been described for one circular cross section discharge nozzle. New design techniques applicable to thick large diameter concrete cylindrical and spherical pressure hull shells have been elaborated. Two major problems seem to cloud the prospect for application of OMNEGS: (a) LWR plant costs have escalated so drastically that OMNEGS economics are border line, and (b) this team lacks expertise needed to identify reactor compartment shell material that would contain a meltdown. Redirection of this project to large offshore coal burning plants is suggested.

OCEAN TEMPERATURE GRADIENTS: SOLAR POWER FROM THE SEA. Melz, W. D. Science; 189: No. 4082, 1286-1287(22 Jun 1973).

Warm ocean water in the tropics moves toward the poles, and ice melts. Cold water at the poles slides into the depths of the oceans and slowly moves toward the equator. In the tropics this cold water provides a nearly infinite heat sink at about 5 C at a depth as shallow as 1000 m. Both the hot surface water and the cold deep water are replenished by solar energy. The temperature differentials in the tropics are not large, but can be used to generate electricity. Far more energy than that consumed throughout the world is potentially available from the seas. In 1964, Hilbert Anderson and James Anderson of York, Pennsylvania, suggested the economic viability of a power plant operated by the ocean thermal gradient. The thermal efficiency of an ocean gradient power plant is low, but the heat exchanger walls may be made thin making it economically feasible. In addition to electricity, an ocean thermal gradient plant could produce fresh water, and hydrogen and oxygen through electrolysis of water. Another product of the plant is food. The artificial upwelling necessary to provide cold water from an ocean gradient plant could be used to cultivate algae, crustaceans,

Thermal Power Systems Using Ocean Temperature Gradients as Source of Energy

AUTHOR: Kariq, S.S.
CONCEPT: AUTHOR: Naval Undersea Center
ADDRESS: San Diego, CA
PUBLICATION DESCRIPTION: Paper No. 72-NA/OCT-12 contributed by the Ocean Technology Division of The American Society of Mechanical Engineers for presentation at the Winter Annual Meeting, New York, NY, November 26-30, 1972, 7 p.

PUBLICATION DATE: 1972
ABSTRACT: Various thermal power systems using the thermal gradient of the ocean were investigated as a source of undersea power for several naval projects such as sea lab or sea floor recovery operations. A Rankine closed cycle system was proposed with the power plant equipment located on the sea floor and the evaporator located in the warm water zone near but below the ocean surface. A variation of the thermal gradient system for the sea floor location was also investigated for oceanic power required for buoys or floating platforms. (auth)

TITLE: Economic Power and Water from Solar Energy
AUTHOR: Anderson, J.H., Jr.
ADDRESS: York, PA
PUBLICATION DESCRIPTION: Paper No. 72-NA/Sol-2, contributed by the Solar Energy Applications Group of The American Society of Mechanical Engineers for presentation at the Winter Annual Meeting, New York, NY, November 26-30, 1972, 8 p.

PUBLICATION DATE: 1972
ABSTRACT: Electric power, fresh water, minerals and food can be produced by solar energy without a large expensive collector. The ocean is the natural collector and reservoir for solar energy. The cost is competitive with today's power cost and there is no environmental pollution. (auth)

AVAILABILITY: The American Society of Mechanical Engineers, United Engineering Center, 395 East 57th St., New York, NY 10017 (\$3.00 per copy, \$1.00 to ASME members)

THE UNITED STATES ENERGY CRISIS: SOME PROPOSED GENTLE SOLUTIONS. William E. Horonemus, (Massachusetts U.). (Presented before a joint meeting of the local sections of ASME and IEEE, West Springfield, Mass., Jan.12,1972). 49p.

Massachusetts U.
American Society of Mechanical Engineers
Institute of Electrical and Electronics Engineers, Inc.

Power sources, Wind
Power sources, Ocean
(Ocean Thermal Gradients) L-1-9-74

1967

DEEP OCEAN WATERS AS A RESOURCE FOR COMBINED MARICULTURE, POWER, AND FRESH WATER PRODUCTION.

A.D. GERARD AND G.A. ROELS.
Trans. Amer. Geophysical Union, 48th Annual meeting, April 16, 1967.
Marine Technology Soc. Jour., v.4, no.5, Sept/Oct '70

Anderson, J. H. and Anderson, J. H., Jr., "Thermal Power from Sea Water," Mechanical Engineering, April 1966.

DESIGN OF A SEA THERMAL ENERGY POWER PLANT.

A.E. Snyder.
Solar Energy, v.3, no.4, Dec.1969, p.49-54.

A unique 8000-kw gross power and sea water conversion plant is described which uses the temperature difference of the ocean to produce usable energy and fresh water. This plant has been designed for installation along coastlines in a semitropical area. Estimated cost is 2.5 to 3 million dollars, including building and erection costs.

1930

Claude, G., "Power From the Tropical Seas," Mechanical Engineering, Vol. 52, No. 12, December 1930.

Nature, v.249, June 21,1974, p.730-733.

Tidal energy from the Severn Estuary

T. L. Shaw

Department of Civil Engineering, University of Bristol, Bristol BS8 1TR, UK

Energy generation from the tides is widely regarded as economically less viable than that from conventional thermal alternatives. Although economic comparisons are unfavourable the potential overall improvements in network operation indicate the true value of new plant.

ENERGY FROM THE SEA - TIDAL POWER.

E.M. Wilson.

Underwater Journal, v.5, no.4, Aug.1973, p.175-186.

The article briefly reviews the incidence and possible developments of sites for tidal energy, the effects of barraging estuaries for such development, and the principles of operation of various kinds of tidal-power schemes, including the integration of the output into power systems.

The experience gained from six years' operation of the Rance scheme at St Malo is discussed and Russian experimental work is described.

Modern developments in the technology are dealt with in the next section where some of the latest ideas are mentioned, and their possible application to the Bay of Fundy and Severn estuary sites is discussed.

1973

FUNDY TIDAL POWER. Chart, R. E. (Univ. of New Brunswick, Canada). Energy Int.: 9: No. 11, 31-36(Nov 1973).

At the Bay of Fundy the tidal range reaches 53 feet making it

desirable for a tidal power plant. Other qualified locations are the Rance Estuary on the Brittany coast of France; in Alaska there are sites with tidal ranges exceeding 33 feet; in the Gulf of California near the mouth of the Colorado River the tidal range reaches 33 feet; the Severn Estuary in England has a tidal range in excess of 15 feet. Argentina, India, Korea, Australia, and the northern coast of Russia have desirable locations. The power and energy that can be developed at any site depend upon the usable head that varies continuously with the tidal regime and is modified by the fluctuation of basin levels resulting from operation of the plant, the area of the developed basin, the capacity of the sluiceways used to fill or empty the basin, the capacity of generating units, and the method of operation utilized. The installed capacity is fixed by economic considerations rather than by the available flow. The same considerations apply to sluiceway capacity that is selected to allow proper filling and emptying of the basin for optimization of energy production. Studies on the feasibility of a tidal plant at Fundy were made in 1969, and technologically, the renewable

1972

TIDAL ENERGY FROM THE BAY OF FUNDY

KEY WORDS: Basins; Environmental engineering; Nuclear power plants; Power; Powerplants; Pumped storage; Tidal power generation; Tidal power plants

ABSTRACT: A new concept in the use of tidal power is proposed for a project in connection with the recent Bay of Fundy studies. This scheme is based on the two-basin principle, extended to perform a pumped storage role using the same facilities. Much increased efficiency results; the 'thermal' input creates operating heads well beyond those from tides alone. The main feature of this plan is the combining of a varying tidal input with off-peak(night-time) storage from thermal plant, for release during the day according to demand.

REFERENCE: Shaw, T. L., and van den Heuvel, J., "Tidal Energy from the Bay of Fundy," CIVIL ENGINEERING-ASCE, December, 1972, pp. 40-42

PUMPED STORAGE AND TIDAL POWER IN ENERGY SYSTEMS.

C.K. Haswell, et al.

J. Power Div., Amer.Soc.Civil Eng., v.98, no.P02, p.201-220, Oct.1972.

Prospects for the use of pumped storage and tidal energy are reviewed. Discussions are included on tidal energy, electric systems, suiting tidal power to electric systems, uniting pumped storage with tidal power, construction, and economic evaluations.

ENERGY FROM FUNDY TIDES. R.H. Clark.

Can. Geog. J., v.85, p.150-163, N'72.

Tidal possibilities in the Bay of Fundy with tables, charts, and maps.

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IEEE International Conference on Engineering in the Ocean Environment, Newport, R. I., 1972.
Ocean '72; record. [New York, Institute of Electrical and Electronics Engineers, 1972] viii, 613 p. illus. 28 cm.
Held Sept. 13-15, 1972 in Newport, R. I.
"IEEE publication 72 CH0 660-1 OCC."

TIDAL POWER

Tidal Energy and Its Development Dr. E. M. Wilson,
University of Salford, England

47

72 Space technology and earth problems. Edited by C.
787 Quentin Ford. Tarzana, Calif., Distributed by the
ACH2 AAS Publications Office [1970]
v.23 xvi, 401 p. illus. 25 cm. (AAS science and
technology series, v. 23).
An American Astronautical Society publication.
Proceedings of an AAS symposium held Oct. 23-25,
1969, at Las Cruces, N.M. P.243-

TIDAL BASIN RESONANCE FOR POWER

M. H. Cobble*

The damped wave equation is solved for the displacement in a channel of linearly varying width and constant depth. The displacement equation is subject to a time dependent forcing function at the open end of the channel, and a dam is at the narrow end of the channel. The general solution of the problem is developed. A graph of the displacement amplification is shown for several positions along the channel.

TIDAL POWER. Proceedings include 25 papers on the various design features, performance, and economy of both already existing and planned tidal power schemes around the world. Several associated problems, such as that of integration of tidal energy into public electricity supply, environmental effects of tidal power development, and selection of structural materials resistant to seawater corrosion are also examined.

Selected papers are indexed separately. Following is part I of the list of titles and authors. Tidal Power in the Bay of Fundy. By F.L. Lawton. Economics of Tidal Power. By F.L. Lawton. Mathematical Model of Tidal Regimes in the Bay of Fundy. By F.E. Parkinson. Sedimentation Patterns in the Bay of Fundy and Minas Basin. By B.R. Pelletier and R.M. McMullen. The Rance River Tidal Power Plant. By G. Mauboussin. Kislaya Guba Experimental Tidal Power Plant and Problem of the Use of Tidal Energy. By L.B. Bernshstein. Tidal Power from Cook Inlet, Alaska. By E.M. Wilson and M.C. Swales. The Tidal Power Plant "San Jose" Argentina. By H.E. Feinzhoff. Some Considerations of a Possible New Role for Tidal Power. By T.L. Shaw. Pumped-Storage Tidal Power. By K.E. Sorensen. The Total Contribution of Tidal Energy to the System. By J.G. Warnock and J.A.M. Wilson. Integration of Tidal Energy into Public Electricity Supply. By E.M. Wilson and B. Severn. Gray, T.J.; Gashus, O.K.; Lawton, F.L.; Parkinson, F.E.; Pelletier, B.R.; McMullen, R.M.; Mauboussin, G.; Bernshstein, L.B.; Wilson, E.M.; Swales, M.C.; Feinzhoff, H.E.; Shaw, T.L.; Sorensen, K.E.; Warnock, J.G.; Wilson, J.A.M.; Severn, B. *Proceedings of International Conference on Utilization of Tidal Power. Atlantic Industrial Research Inst. Nova Scotia Technical Coll. Halifax, May 24-29 1970* Plenum Press, Div Plenum Publ Corp, New York, 1972. 639 p.

Tidal power

Anon., Electr Rev., 187, (3), 73, (17 July 1970). The main reason for the rejection of the Bay of Fundy scheme by the Atlantic Tidal Power Programming Board was the current high interest rate of 7% on the estimated capital cost (£93/kW installed). Tidal power will be one of the alternatives investigated however when New Brunswick Electric Power Commission next reviews its generation programme.

A reconsideration of tidal power; T.L. SHAW (Univ of Bristol, England). S.W. HUNTINGTON; Water Power v 22 n 5-6 May-June 1970 p 219-24; The various combinations of basin, turbines and tides that could serve different conditions are examined. From the various calculations that were carried out, it is concluded that single-basin single-tide working is the preferable technique for harnessing tidal power, particularly when a high level in the basin is desirable. 8 refs.

TIDAL BASIN RESONANCE FOR POWER. M.H. Cobble.

P.243-

Space Technology and Earth Problems. Edited by C. Q. Ford. (Proceedings of an AAS symposium held Oct. 23-25, 1969, at Las Cruces, N.M.)

TL787.A6A2, v.23

Soviet tidal power

Anon., Energy Int., 6, (1), 29, (Jan. 1969). The first tidal station on the USSR under construction near Murmansk (with an annual output of 4 000 GWh) will be followed by the Lambor 300 MW, Menza Bay 1 300 MW, and White Sea 5 000 - 6 000 MW stations. Total annual output of tidal stations in the USSR will eventually amount to 100 000 GWh.

Tidal power becoming more feasible

Brundrett, F., Electr Rev., Lond., 185, (22), 787, (28 Nov. 1969). Developments in engineering technology, construction techniques, and control of the generating cycle are increasing tidal power feasibility. The continual increase in power demands make the inherent large scale of tidal power stations advantageous.

Integration of pumped storage with tidal power with particular reference to the Severn Estuary

Thorpe, G.R., (NLL D Integration of pumped storage ...), University of Bristol Dept. Civil Engineering, (June 1969). 80 pp.

TCL45.D3
1969 RR

Handbook of applied hydraulics.
C.V. Davis & K.E. Sorensen, Eds.
McGraw Hill 1969.

618

TIDAL ENERGY DEVELOPMENT. E.M. Wilson.
P.42-1 - 42-25.

1970

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1969

"Tidal & Wave Power"

(3 refs) (6-32 to 6-34)

"Handbook of Ocean & Under-water Engineering" 1969

TC 1645

#35 HR

1968

Soviet's first tidal station

Anon., Energy Int., 9, (3), 42, (Mar. 1968). Experimental turbines will be actuated by rise and fall of nearly 80 feet.

Optimization of tidal power generation

Swales, M.C., and Wilson, E.M., Wat. Pwr., 20, (3), 109-114, (Mar. 1968). Energy and economic optimization using a computer.

Magnetohydrodynamics considered for tidal generation

Anon., Electl Times, 154, 20, (4 July 1968). In a recent paper by R. R. Lloyd presented to the Engineering Institution of Canada, it is suggested that MHD tidal power generation might be economical within 10 years. Within a few years superconducting magnets should provide high enough flux densities to make feasible MHD generation using the velocities obtained from tidal flow of sea water. Despite many difficulties, a system is proposed based on 120 units each of 0.8 MW.

Tidal power with special reference to plant, construction techniques and the integration of the energy into existing electricity systems

Wilson, E.M., et al., Wat Pwr Conf., Plenary Meet., Moscow, Aug. 1968. Future tidal power development is reviewed, and an assessment made of the tidal power pumped storage method. For a typical scheme the cost of energy at the barrage has been estimated at 4 mills/kWh. Taking into account the energy supplied via pumped storage, the corresponding average energy cost would be 6 mills/kWh, and so, in certain areas, tidal power is competitive with any alternative peak energy source.

619

Tidal power: a new opportunity?

Braithwaite, M., Engineering, Lond., 208, (5342), 359, (6 Sept. 1968). The energy produced is either used for peaking on the system or else as pumping power for a high-head pumped-storage plant, depending on the time, in relation to the electrical demand, at which favourable tidal conditions occur. BC

Estimated Effects of Barrage on Tides in Bristol Channel, N.S. HEAPS. Instn Civ Engrs—Proc v 40 Aug 1968 p 495-509. Possibility of harnessing great amount of tidal energy in Bristol Channel by construction of hydroelectric barrage scheme is considered; study was conducted to determine how introduction of barrage across flow would affect overall tidal conditions in channel; estimates are made of changes which might occur in both tidal elevation and current; method employed is based on integration of one-dimensional hydrodynamical equations for channel, using step-by-step numerical procedure.

Tidal power with special reference to plant, construction techniques and the integration of the energy into existing electricity systems

Braithwaite, M., et al., Wat Pwr Conf., Moscow, Section C2, Pap. 349, (28-31 Aug. 1968), 27 pp. Critically examines inherent limitations of the La Rance tidal power station, France, which exploits the pump/turbine concept. The pump/turbine method is compared with the more adaptable tidal power pumped storage (t.p.s.) method, where the primary low-grade energy generated on the ebb tide is stored, when not immediately required. The t.p.s. concept is more economic when the barrage generating plant is simple and robust. Describes the straight flow turbine and rim-generator, which satisfy these conditions, the way in which the number of turbines and sluice-gates may be selected so energy costs are optimized, ways of adapting the caisson method as the power station sluices may be built and largely equipped before being floated into position and sunk on a prepared foundation, prospects of future tidal power, and the economics of t.p.s. For a typical scheme the cost of energy at the barrage is estimated at 4 mills/kWh.

Optimization of Tidal Power Generation, M.C. SWALES, E.M. WILSON. Water Power v 20 n 3 Mar 1968 p 109-114. Method for energy and economic optimization of tidal power generation by using computer is described; method is explained in relation to ebb-generation schemes, but could be applied to multiple basin and simple two-way generation design where pumping is not proposed; results are given from study of tidal generation in Bristol Arm, Alaska.

1968

1968

Anon., *Electr Rev.*, Lond., 180, (6), 319, (3 Mar. 1967). A tidal power scheme for the Bristol Channel using two separate basins has been proposed by E. N. Underwood and Partners and Sir Frederick Snow and Partners. The scheme would have a continuous power output of 1 800 MW or 5 000 MW for three hours per day. Details of the plan, which would cost £400 million, have been discussed with the MoP and CEB. Equinoctial tidal levels could be established throughout the year by lowering the level of basin B at low tide and raising the level of basin A at high tide, using separate pumps installed in the barrages.

Undercurrent power plants, a variation of tidal power

Anon., *Power*, 111, (6), 147, (June 1967). As ocean current flows through a funnel-shaped orifice, its speed increases substantially, e.g. from 2.3 mph to 34.5 mph. The high-speed current could be made to drive underwater turbines and generate electricity.

A fundamental approach to tidal power

Fentzloff, H. E., *Wat. Pwr.*, 19, (6), 318-322, (Aug. 1967). A comprehensive systemization of water power utilisation on a dimensionless basis. From this work is formulated the "Law of Anththesis" as between river and tidal power utilisation. The failure to recognise this law is the reason why complete utilisation of tidal power has not been achieved. Supports the suggestions made by E. M. Wilson, but considers the double cycle to be superior to the single cycle system.

Tidal power from the Severn

Anon., *Engineer*, Lond., 223, (5802), 513, (7 Apr. 1967). A proposal for a two-basin scheme for tidal power generation in the Severn estuary has been put forward jointly by two firms of consulting engineers, E. N. Underwood and Partners and Sir Frederick Snow and Partners. The scheme is illustrated and described. It is estimated that annual power output could be 11.3 TWh. Cost of the scheme would probably lie between £360-400 m. Some comparison is made with another scheme. Editorial comment is offered.

- GC
301
.S95
1967
- Symposium on Tides, Monaco, 1967.
Proceedings of the Symposium on Tides organized by the International Hydrographic Bureau. Actes du Symposium sur les marées organisé par le Bureau hydrographique international, Monaco, 28-29 avril 1967. Paris, Unesco, 1969.
205 p. illus. 27 cm.
English and/or French.

620

1966

TIDAL POWER COMES TO FRANCE.

Engineering, v.202, July 1966, p.17-24.

This month the world's first tidal power station starts generating. Situated in Rance estuary in north-western France, it utilizes one of the highest tidal ranges in the world.

1965

Fundy Tidal Power--Canada's Biggest Project, B.C. MINER, *Eng. & Eng. v. 74 n. 10 Oct 1965 p.46-9*. Study for development of tidal energy on Minas Basin in Canada, is considered short sighted since it develops only part of full potential; dam across Bay of Fundy is proposed to develop full potentially available tidal power of about 75 million kw; preliminary analysis showing feasibility of dam across Fundy Bay; technical aspects of tidal energy.

Solway Firth Tidal-Power Project, E. M. WILSON, *Water Power v. 17 n. 11 Nov 1965 p.431-9*. Study of technical and economic feasibility of developing tidal energy on Solway Firth, shallow inlet of Irish Sea in England, estimates of probable cost of necessary works in Solway Firth and calculations of available tidal energy under various regimes and plant dispositions; method of integrating tidal energy with mixed thermal, nuclear and hydro generation of combined North and South of Scotland system examined; integration of tidal energy into combined system is achieved by using proposed Loch Eloy pumped-storage scheme developed to 1300 Mw.

1965

POWER FROM THE TIDES.

J. Dupont, et al.

Int. J. Sci. & Tech., May 1965, p.34-40, 89,90.

By adapting lunar rhythm of the tides to the solar cadence of our daily needs we can harness the endless energy of the oceans that ebb and flow across our shores.

1965

Feasibility Study of Tidal Power from Loughs Strangford and Carlingford with Pumped Storage at Rosstroror, E. M. WILSON, Irish Civ. Engrs.-Proc. v 32 Sept 1965 p 1-29. Cost of tidal power, as it could be generated at two sites in Northern Ireland, is evaluated; recent developments in low-head turbine and generator design and in development of reversible pump turbines for high heads are bringing cost of tidal energy, even at sites with quite low tidal ranges, into competition with other more conventional power sources; author treats proposed development in detailed way and shows how proposals might be implemented against background of existing, almost exclusively thermal, power supply system in Northern Ireland.

Built Turbines Will Harness Tides and Supply Power to French Grid, F.C.LIVINGSTONE, Power Eng v 69 n 6 May 1965 p 46-48.

Flow of River Rance water at high tide will turn 24 double-action turbines and produce peak output of 240 Mw; at flood tide and ebb tide, flow of water reaches 23,540 cu yd/sec; 1234-ft long concrete tunnel constitutes engine room, and has its floor at zero of low tide; engine room consists of 24 bulb sets, each having capacity of 10 Mw; power will be produced at 3.5 kv and sent out by three 80,000-kw transformers at 225 kv.

1964

Potential of Tidal Power on North Atlantic Coast in Canada and United States, J.T.LABA, Coastal Engr. 2nd Conference-Buff June 1964 p 832-87. Most suitable locations for erection of tidal power plants on North Atlantic Coast are reviewed and classified in respect to possible pool arrangement; harnessing of tides to produce power in various layouts is described; power output from two proposed tidal power projects, Passamaquoddy Bay and Shepody Bay is compared and some auxiliary power sources to supplement varying output of tidal power are discussed; tide producing forces and effect of canals on tide height.

Rance Tidal-Driven Power Plant, M.LONGEAUX, Indust. J. Power & River Valley Development v 14 n 11 Nov 1964 p 33-7. Construction and state of progress of Rance, on the northern coast of Brittany world's first tidal-driven power plant; during highest tides, volume of water cycle four times every 24.5 hr and flows reach 18,000 cu m/sec; structure as whole, with its piers, may be likened to conventional mobile dam for harnessing low heads, with peculiarity that sluice gates must withstand pressures on both faces; between two structures lies power house proper, consisting of 24 "bulb" sets generating 10 Mw, transformers and auxiliary services.

1964

QUODDY QUESTION--TIME AND TIDE.

G.D. Friedlander.

IEEE Spectrum, v.1, no.9, Sept.1964, p.96-102, 107-118.

Historical back-

ground and present status of Tidal Power Project for generating electric power in Passamaquoddy Bay area on border between Maine and New Brunswick by harnessing power of great tides; discussion of construction problems, cofferdamming, filling and emptying gates, navigation locks, flood control and economic factors; description of analogous La Rance project in Brittany, France, with capacity of 240 Mw in 24 turbine sets; comparison between these projects; summary of studies by various government agencies; graphs and maps.

HYDROELECTRIC POWER: A NON-RENEWABLE RESOURCE?

Ian C.T. Nisbet.

Technology Review, June 1974, p.5,64.

United States has little potential for significant hydroelectric development: most of the best sites are already exploited, and even damming the Grand Canyon would do little to relieve the nation's energy problem. But in the present climate of resource crisis and environmental concern, even small projects are attractive enough to put their opponents on the defensive. Elsewhere in the world, hydro schemes have much greater economic appeal, and vast projects are underway—if all the dams on the drawing board come to fruition, most of the major rivers of the world will be under control within 50 years.

CHEAP POWER—AN EXPENSIVE FAILURE: HYDRO-ELECTRIC POWER AND INDUSTRIAL DEVELOPMENT IN NEWFOUNDLAND. Several problems associated with the water resources and hydro-electric power developments are discussed from the economy point of view. 19 refs.

Crabb, Peter Macquarie Univ, NSW, Aust. *Water Resour Bull* v 10 n 1 Feb 1974 p 42-53.

Evaluation Report: Water Resources Appraisal for Hydroelectric Licensing. Mottville Development Project No. 401, Owned by Michigan Power Company, St. Joseph River, Michigan and Indiana.
Federal Power Commission, Washington, D.C. 1974. 51p
PB-228 559/1WE PCS3.75/MF\$1.45

The report on the Mottville development pertains to the development of the hydroelectric power potential of the St. Joseph River Basin within the limitations of other desirable water uses and environmental concerns.

ELECTRICAL FEATURES OF THE CHURCHILL FALLS DEVELOPMENT.

R.H. Stuart, et al.

IEEE Trans. **Power App. & Syst.**, v.PAS-93, **Jan./Feb.** 1974, p.340-

This paper contains a brief outline of the principal elements of the 522.5-MW Churchill Falls hydroelectric power development, together with a review of the significant electrical features. It describes the 500-MVA generating units, the arrangement of busses, transformers and 240-kV cables used to transmit energy from the underground powerhouse to the surface, the 735-kV switchyard, the auxiliary power system, protective relaying, control and annunciation schemes, and the data logging computer installation.

Energy and Development: A Case Study. (M.I.T. Report No. 25). Compiled by & Edited by William W. Seifert et al. 1973. M.I.T. Press. 28 Carleton St., Cambridge, Mass. 02142. 300 pp., paper. \$11.00.

The object of this study is to determine the feasibility of utilizing the energy resources available in the coastal region of Saudi Arabia adjacent to the western shore of the Arabian (Persian) Gulf for the development of an agro-industrial complex in that area. The book actually comprises two studies. The first is based on utilizing natural gas to power a number of hydropotential projects, which are then weighed in terms of their economic viability. The second study is based on a novel means of hydroelectric power generation—heliohydroelectric.

1973

THE CONTROL OF THE WATER CYCLE.

J.P. Peixoto and M. Ail Kettani.

Scientific American, Apr.1973, v.228, No.4, p.46-61.

The recent emphasis in hydrologic studies on the crucial role played by the general circulation of the atmosphere has led to schemes for altering this vast natural process.

1972

TITLE: Hydroelectric Power Resources of the United States.
 CORPORATE AUTHOR: Federal Power Commission, Bureau of Power
 ADDRESS: Washington, DC
 PUBLICATION DESCRIPTION: Report No. PPC P-82, 126 p.

PUBLICATION DATE: 1972, January 1
 ABSTRACT: This publication, the sixth in this series issued by the Federal Power Commission, presents data as of January 1, 1972, on the capacity, generation, and other characteristics of the developed and undeveloped hydroelectric power resources of the United States. Principal statistics are shown by major drainages and river basins and by geographic divisions and States. This series of reports is the only single source of such data in the United States. Earlier editions were published for the years 1953, 1957, 1960, 1964, and 1968. Expanded coverage is given pumped storage projects, recognizing the increasing importance of such developments. The tables of licensed projects and of Federal projects have been changed to include both conventional and reversible capacity. The definitions of selected terms used in the report have been added. As in the earlier editions, however, the principal listings and summaries of developed and undeveloped hydroelectric power include only conventional installations. (Auth, from Preface)

AVAILABILITY: GPO

623

1972

HELIOHYDROELECTRIC (HHE) POWER GENERATION
 Kettani, M. A.; Gonsalves, L. M. (Coll. of Petroleum and Minerals, Dhahran, Saudi Arabia). Solar Energy 14: No. 1, 29-39 (Dec 1972).

Solar energy can be efficiently converted into electricity by transforming it into hydraulic energy as in nature. This can be done "artificially" when the topographical and hydrological conditions are favorable. For instance, Dawhat Salwah of the Arabian Gulf (Persian Gulf) can be transformed easily into a large water reservoir, by building a dam from Saudi Arabia to Bahrain, and another from Bahrain to Qatar. Because of evaporation, the level of the "closed reservoir" will tend to decrease, inducing a flow to move from the "open sea," to restore the level to its initial value. Therefore the flow of water evaporated by the sun is transformed into a discharge from the "open sea" to the "closed reservoir." Solar energy of evaporation has thus been transformed into hydraulic energy. If a physical head, H_e , is set between the two levels the potential energy thus formed by the discharge, falling along H_e , could be transformed into electrical power. The value of this power is related to the physical and meteorological characteristics of the chosen "closed basin." The entire system is studied theoretically as an "electric gen-

1972

SOLAR DEPRESSION POWER PLANT OF QATTARA
 IN EGYPT. Baseler, F. (Technical Univ., Darmstadt, Ger.). Solar Energy 14: No. 1, 21-28 (Dec 1972).

In the Libyan Desert of North Africa, only 80 km away from the Mediterranean, a vast depression 300 km long and 150 km wide can be found, the floor of which at its lowest point lies 135 m below sea level. If seawater is conducted to the northern edge of this depression by an open channel or an underground supply line, the difference of elevation between the Mediterranean and the bottom of the depression can be used for generating power in water turbines. Although the depression has no outlet, the utilized water is subjected to very high evaporation from this area. Years of survey have shown an average remaining evaporation of 1800 mm per annum. Optimum efficiency of the power plant is achieved when equilibrium prevails between the amount of water flowing in and the amount evaporating by the sun's energy into the atmosphere. In the Qattara Depression near El Alamein this state can be achieved as soon as the water level has reached -60 m, corresponding to a surface area of 12,000 km² and to an annual evaporation volume of more than 20,000 million m³. Thus a seawater discharge of at least 650 m³/sec can be continuously fed into the turbine of the power plant without the level in the

THE KETTLE HYDRO-ELECTRIC DEVELOPMENT ON THE NELSON RIVER.

L. Ingram and W. Gouldsborough.
IEEE Trans. Power App. & Syst., v.PAS-90,
May/June 1971, p.1207-

The Kettle hydro-electric development by Manitoba Hydro is located on the Nelson River in the Province of Manitoba and is unique in that, up to now, it is the only generating station in the Western world which will feed exclusively into a dc transmission system. Because of this, some features associated with this plant are somewhat different from conventional hydro-electric developments and this paper will describe these features together with certain other electrical and mechanical aspects of the project.

TITLE: Hydroelectric Power Policy

AUTHOR: Price, T.P.
CORPORATE AUTHOR: National Water Commission
PUBLICATION DESCRIPTION: PB 204 052,
NWC-SDS-71-012, 63 P.
PUBLICATION DATE: 1971, February

POWER FROM LABRADOR: THE CHURCHILL FALLS DEVELOPMENT.
G.D. Friedlander.

IEEE Spectrum, Feb.1971, p.81-91.

One of the worlds largest hydroelectric projects has passed the halfway mark toward completion.

COMPOSITE REPRESENTATION OF A MULTIRESERVOIR HYDROELECTRIC POWER SYSTEM.

N.V. Arvan'tidis.

IEEE Trans. Power App. & Sys., v.PAS-89,
no.2, Feb.1970, p.319-

Abstract—A composite model for multireservoir hydroelectric power systems is constructed for studying the monthly decision concerning total hydrogeneration. This is an important decision when the inflows are uncertain and when hydro, with zero marginal cost, can be used not only to satisfy firm load commitments but also to displace other firm resources or to serve secondary loads. In such a case, the tradeoff between savings at the present and expected benefits in the future is determined mainly by the total hydrogeneration. The construction of a composite representation for the multireservoir hydroelectric power system in the Pacific Northwest is described. The composite model is based on a single measure "potential energy" which is indicative of the system's generating capability. This results in a one-dam representation of the multireservoir system which, in effect, receives, stores, and releases potential energy, in a statistical model for the potential energy inflow and in a generation function which relates potential energy released to actual electric power generated. It has applications in the study of different operating policies, market structures, and investment programs through simulation or optimization. As an example, it is used to obtain the net operating revenues as a function of the excess thermal in the system.

72V23879 1968 ISS:00 TD224.T4R333 NO. 81 621.31213409764 LC-68-66781
R/GODFREY, F. A.

MAJOR ♦♦ HYDROELECTRIC ♦♦ POWERPLANTS IN TEXAS; HISTORICAL AND
DESCRIPTIVE INFORMATION; BY F. A. GODFREY AND C. L. DOWELL.
TEXAS WATER DEVELOPMENT BOARD; (AUSTIN) VII, 93 P. ILLUS. 28 CM.
TEXAS. WATER DEVELOPMENT BOARD. REPORT 81 BIBLIOGRAPHY: P. 93.

LC:WATER POWER ELECTRIC PLANTS -- TEXAS.

ADDED:N♦US♦TX DOWELL; CLEO LAFAY, JOINT AUTHOR.

MAIN-AUTH TRACE-SER3♦TITL♦AUTH♦ CATLG BY-LC

J. MAGNETOHYDRODYNAMICS AND ELECTROHYDRODYNAMICS

1974

N74-16800* # National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
H2-O2 COMBUSTION POWERED STEAM-MHD CENTRAL POWER SYSTEMS *also A74-27775 #*
 G. R. Seikel, J. M. Smith, and L. D. Nichols 1974 14 p refs
 Presented at Hydrogen Economy Miami Energy Conf., Miami Beach, Fla., 18-20 Mar. 1974; sponsored by Univ. of Miami (NASA-TM-X-71512; E-7890) Avail: NTIS HC \$3.00 CSCL 108

Estimates are made for both the performance and the power costs of H2-O2 combustion powered steam-MHD central power systems. Hydrogen gas is assumed to be transmitted by pipe from a remote coal gasifier into the city and converted to electricity in a steam MHD plant having an integral gaseous oxygen plant. These steam MHD systems appear to offer an attractive alternative to both in-city clean-fueled conventional steam power plants and to remote coal-fired power plants with underground electric transmission into the city

Author

1974

N74-19697* # National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
NASA LEWIS H2-O2 MHD PROGRAM
 Martin Smith, L. D. Nichols, and G. R. Seikel 10 Apr. 1974 8 p refs Presented at the 14th Symp. on Eng. Aspects of Magnetohydrodynamics, Tullahoma, Tenn., 8-10 Apr. 1974 (NASA-TM-X-71520; E-7907) Avail: NTIS HC \$4.00 CSCL 10A

Performance and power costs of H2-O2 combustion powered steam-MHD central power systems are estimated. Hydrogen gas is assumed to be transmitted by pipe from a remote coal gasifier into the city and converted to electricity in a steam MHD plant having an integral gaseous oxygen plant. These steam MHD systems appear to offer an attractive alternative to both in-city clean-fueled conventional steam power plants and to remote coal-fired power plants with underground electric transmission into the city. Status and plans are outlined for an experimental evaluation of H2-O2 combustion-driven MHD power generators at NASA Lewis Research Center.

Author

1974

N74-18557* # National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
LIGHT BULB HEAT EXCHANGER FOR MAGNETOHYDRODYNAMIC GENERATOR APPLICATIONS - PRELIMINARY EVALUATION
 J. Martin Smith, Charles C. Hwang (Pittsburgh Univ.), and George Seikel, R. Washington Mar. 1974 29 p refs
 (NASA-TN-D-7534; E-7593) Avail: NTIS HC \$3.25 CSCL 20M

The light-bulb heat-exchanger concept is investigated as a possible means of using a combustion heat source to supply energy to an inert gas MHD power generator system. In this concept, combustion gases flow through a central passage which consists of a duct with transparent walls through which heat is transferred by radiation to a radiation receiver which in turn heats the inert gas by convection. The effects of combustion-gas emissivity, transparent-wall-transmissivity, radiation-receiver emissivity, and the use of fins in the inert gas coolant passage are studied. The results indicate that inert gas outlet temperatures of 2500 K are possible for combustion temperatures of 3200 K and that sufficient energy can be transferred from the combustion gas to reduce its temperature to approximately 2000 K. At this temperature more conventional heat exchangers can be used.

Author

1974

N74-19338* # National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
CLOSED CYCLE MHD POWER GENERATION EXPERIMENTS IN THE NASA LEWIS FACILITY

Ronald J. Sovie and Lester D. Nichols 1974 9 p refs Presented at the 14th Symp. on Eng. Aspects of Magnetohydrodynamics, Tullahoma, Tenn., 8-10 Apr. 1974 (NASA-TM-X-71510) Avail: NTIS HC \$4.00 CSCL 201

Many modifications were made in the MHD facility. These include a redesign of the MHD duct interior, addition of mixing bars, increased electrical isolation of all the high temperature components from each other and from ground, and experimentation with various cesium seed vaporization and injection techniques. With the exception of the cesium system which needs further improvement the above modifications were quite successful and resulted in improvements in generator performance. The facility was run for a total of 400 hours in the past year, with 70 hours of this operation at temperatures of 2000 K or more with hot generator walls. With the exception of replacing one cracked brick in the MHD channel no repairs were required in the high temperature loop components for the duration of these tests. Uniform Faraday and Hall voltage profiles were obtained and the Faraday open circuit voltage varied from 90 to 100 percent of the ideal uB. The magnitudes of the measured parameters are: Faraday open circuit voltage approximately 70 V, total Faraday current approximately 20 A, Hall voltage approximately 250 V, power output approximately 300 W, and power density .036 W/cu cm.

Author

CE-140,568
COAL TECHNOLOGY: KEY TO CLEAN ENERGY. ANNUAL
REPORT 1973-74. 1974. 147p.

Office of Coal Research
(Washington, D.C.)

Coal
Coal - Gasification
Fuels - Synthesis
Generators, Magneto-hydrodynamic
Research - Office Coal Research
(Amer.)

Research - Coal
L-5-24-74

Development of Design Criteria, Cost Estimates, and
Schedules for an MHD High Performance Demon-
stration Experiment
Issued January, 1974
R&D Report No. 76—Final Report
Contractor: Arnold Engineering Development Center,
Department of the U.S. Air Force
Refer to: Titled report and GPO Catalog No. 163.10:76
Price: \$1.75

Thermal Cycle and Efficiency of a Versatile Power Unit with a
Magneto-hydrodynamic Generator and Thermoelectric
Generator.
V. A. Kirillin, A. E. Sheindlin, E. M. Shelkov, E. V.
Shishkov, and S. A. Pashkov.
Joint Publications Research Service, Arlington, Va. 1 Mar
74. 10p
JPRS-61359 PC\$3.00/MF\$1.45

The reports contains a description of a MHD generator circuit
with an overload mode capacity making operation possible in a
wide range of loads.

TITLE: Closed-Cycle MHD Potential Impressive
AUTHOR: Zauderer, B.
CORPORATE AUTHOR: General Electric Co., Space
Sciences Laboratory, Valley Forge Space Center
ADDRESS: Philadelphia, Pa
PUBLICATION DESCRIPTION: Electrical world,
181(6), 94-95

PUBLICATION DATE: 1974, March 15
ABSTRACT: The problems associated with high
operating temperatures necessary for
open-cycle MHD energy conversion can be
overcome if the electrical conductivity of
the gas is enhanced by induced electric
fields in the generator. The conductivity
effect can be obtained only in an
alkali-metal-seeded monatomic gas, such as
argon. The high cost of argon necessitates
the continuous recirculation of the gas.
Energy conversion efficiencies of over 60
percent are predicted in such a system. (DCN)

Cryogenics & Industrial Gases, v.9, no.1, Jan/Feb.1974.

MHD: A realistic solution to the energy crisis15

This report, compiled by New York economic consulting firm
Lionel D. Edie & Company, says the economics of this power gen-
eration method justify further funding, emphasis and support by
government, utilities, coal producers and other suppliers to
utilities.

Thermodynamic Data for Air Preheaters in Direct Coal-Fired
Magneto-hydrodynamic Power Generation Systems.
F. E. Spencer, Jr., and J. C. Hendrie, Jr.
Bureau of Mines, Washington, D.C. Jan 74, 58p BuMines-
IC-8611 Paper copy available from GPO \$0.85 as 128.27:8611
and Stock no. 2404-01490.
PB-228 109/SWE PC-GPO/MF\$1.45-NTIS

Calculated equilibrium composition and thermodynamic func-
tions for three phases in the flue stream from a hypothetical
open cycle MHD generator fired with coal combustion
products. Stoichiometry specified as 1.0 kilogram of average
Upper-Frèport seam hvBb coal plus 1.0 gram mole K₂O plus
101% of stoichiometric air:slag rejection figures of 75 and
90%. Data useful in design of high temperature air preheaters.
Brief discussion of certain points of agreement between ex-
periment and present mathematical model. (Author)

**Dynamic Modeling and Analysis of Liquid-Metal
Magnetohydrodynamic Power Systems.**

Chun Hsu, and Ho-Tien Shu.

New Technology Inc Huntsville Ala Mar 74, 149p

NTI/T1065A

AD-778 757/SWE PC\$4.75/MF\$1.45

A comprehensive survey of the current development status of all MHD power cycles was made to assess the relative merit of the various cycles for naval applications. Dynamic System model was formulated to analyze the system performance. First, detailed component model was formulated and component designs were performed to determine the geometric configuration of each component. Next, a method based on variational 27 principle and the steady-state system solutions was developed to determine the component node models. A manageable dynamic system model and a simplified linear system model were then formulated. Finally, system stability analysis on the linear node model was performed to examine the local system stability. (Author)

Magnetohydrodynamic Generators.

E. I. Yantovskii, and I. M. Tolmach.

Foreign Technology Div Wright-Patterson AFB Ohio 9 Apr

74, 760p FTD-MT-24-238-74

AD-779 787/IWE PC\$15.00/MF\$1.45

The monograph discusses problems of the theory, calculation and design of magnetohydrodynamic generators, and also some experimental studies relating to them.

N73-28657* Georgia Inst. of Tech., Atlanta.

POWER PLANT SYSTEMS ANALYSIS

J. R. Williams and Y. Y. Yang In *its* Satellite Nucl. Power

Station: An Eng. Anal. Mar 1973 p 63-118

CSC 18E

Three basic thermodynamic cycles of advanced nuclear MHD power plant systems are studied.

AD-778 435/AGA PC\$3.25/MF\$1.45

Systems Research Labs Inc Dayton Ohio

**EXPERIMENTAL CHARGE PRODUCTION IN
A TWO-DIMENSIONAL ELECTROFLUID**

DYNAMIC TEST GENERATOR.

Technical rept. Mar 71-Jan 72.

Russell W. Griffith, Jan 74, 39p ARL-74-0002

Contract F33615-70-C-1515

Descriptors: *Electrohydrodynamics, *Electrical corona, Electric charge, Production, Nozzle gas flow, Electrodes.

The effects of pressure and electric field strength on corona are presented with the goal of showing how corona can be produced under favorable to the EPD process. Unique properties of the two-dimensional electric field are shown along with their effects on corona charge production. Experiments are described which compare the performance of various corona electrodes in the amount of current they can produce under similar conditions, as well as the effects of pressure and relative humidity levels on corona current. The effect of an electric distribution in producing a non-uniform electric field is shown. One electrode shape, the flat-edged corona disc, was found to be superior to the others in the amount of current produced, durability, attractor voltage required, and anticipated operation at very high pressure levels. (Author)

QC809.M3593 1973

A73-38310 Engineering aspects of magnetohydrodynamics; Proceedings of the Thirteenth Symposium, Stanford University, Stanford, Calif., March 26-28, 1973. Symposium sponsored by Stanford University. Edited by M. Mitchner. University, Miss., University of Mississippi, 1973. 366 p. \$15.

Calculation and measurement of MHD generator boundary-layer velocity profiles, stability of a nonequilibrium helium-cesium MHD plasma in a regime of fully ionized seed, and thrust stand performance measurements of a lithium fueled applied field MPD arcjet are among the topics covered in papers concerned with plasma flows and instabilities. Other areas covered include liquid-metal generators, system and design studies, and pollution and combustion plasma properties.

M.V.E.

(AD-766588-8) EXPERIMENTAL TWO-PHASE LIQUID-METAL MAGNETOHYDRODYNAMIC GENERATOR PROGRAM. Annual Report, 1 May 1972-1 May 1973. Amend. W. E.: Cole, R.; Cutting, J. C.; Pittenger, L. C. (Argonne National Lab., Ill. (USA)). Jun 1973. Contract NA00r-19-72. 78p. (ANL/ENG-73-2). NTIS \$3.75.

Extensive data on the contoured generator has been taken which corroborates the very preliminary data reported previously. Detailed experimental parametric studies were completed which mapped generator performance as a function of mixture quality, magnetic field, and generator loading. Turbine efficiencies of 50% have been achieved for the first-generation contoured generator. The experimental data, coupled with theoretical analyses and modeling, however, has shown conclusively that an electrical shunt exists within the generator. Extensive data has also been taken on the generator with constant cross-sectional inserts; similar results were obtained. Several possible causes for the electrical shunt were identified. In order to identify and isolate the principal electrical shunt, the following steps were taken: the generator was redesigned and rebuilt to completely eliminate leakage and thus the shunt behind the insulator wall; a gas-cleaning system and a micropore NaK filter was installed to minimize the amount of gas impurities that could enter the test facility and remove any oxides as soon as they are formed. These steps were successfully carried out and a new series of performance runs are planned. As the testing proceeds, the effects of the mechanical and fluid boundary-layer-type shunts can be separated. Control of the boundary-layer shunt will be accomplished with a gas injection system. (auth)

TITLE: Air Pollution Aspects of MHD Power Generation

AUTHOR: Blenstock, D.; Bergman, P.D.; Reedy, J.H.; Denstli, R.J.; Deseter, J.J.; Plants, K.D.

CORPORATE AUTHOR: U.S. Dept. of Interior, Bureau of Mines, Pittsburgh Energy Research Center;

U.S. Dept. of Interior, Bureau of Mines,

Morgantown Energy Research Center

PUBLICATION DESCRIPTION: Paper presented at 13th

Symposium on the Engineering Aspects of

Magnetohydrodynamics

PUBLICATION DATE: 1973

ABSTRACT: Magnetohydrodynamics has very low air-pollution potential. In pilot plant tests in which a 2.2 wt-% sulfur coal was burned in a cyclone furnace at 200 lbs/hr and 2000 degrees F (2500 degrees K) at a seed concentration of 1 g mole K₂CO₃/kg coal, 99.8% removal of SO₂ was obtained with only 5 ppm SO₂ in the gaseous effluent. Operating the combustor with 95% of stoichiometric oxygen and ambient air admitted at 2000 degrees F (1370 degrees K), NO_x emissions decreased to 150 ppm or 0.12 lb NO₂/million Btu. This represents a 94% reduction from single-stage operation at 102% of stoichiometric oxygen. As the gas-cooling rate in the experimental unit is higher than projected for a commercial plant, it is expected that a commercial plant would experience even lower NO_x emissions. A mathematical model using the Zeldovich mechanism was adequate to follow the NO_x decomposition in the air-rich system; an extended Zeldovich was more appropriate in the fuel-rich regime. Experiments showed that at high slag-rejection rates of greater than 90%, recovery of the potassium seed by aqueous extraction was better than 99%. Cost estimates of a 1000 MWe MHD-steam plant, in which the spent seed is recovered by aqueous extraction and then regenerated with reducing gases to remove the sulfur, showed an operating cost of the seed recovery-sulfur removal steps of 8% of the overall power costs of 10.3 mills/kwh. Seed make up costs have a marginal impact even at potassium recoveries as low as 95%. The capital costs of SO₂ removal is \$10.4/kv, approximately 1/5 of that in conventional power plants. (auth)

AVAILABILITY: Dr. John Fox, Dept. of Mechanical Engineering, University of Mississippi, University, MS 38677 (\$15.00 for entire proceedings)

1973

TITLE: A Cesium-Lithium MHD Topping Plant for Central Station Power Generation
AUTHOR: Hays, L.G.; Phen, R.L.; Zygierbaum, P.S.
CORPORATE AUTHOR: California Institute of Technology, Jet Propulsion Laboratory
ADDRESS: Pasadena, CA
PUBLICATION DESCRIPTION: Paper presented at 13th Symposium on the Engineering Aspects of Magnetohydrodynamics, 9 p.
PUBLICATION DATE: 1973, March
SPONSOR: National Aeronautics and Space Administration

ABSTRACT: Liquid metal magnetohydrodynamic power systems were investigated to determine the feasibility of their usage as topping plants for central station steam turbine power systems. The performance of large, multistage cesium-lithium and potassium MHD power systems was analyzed. The results showed efficiencies as high as 15% were attainable for a 2500 MW cesium-lithium system operating with approximately 1250 degrees K (1800 degrees F) maximum temperature and approximately 840 degrees K (1050 degrees F) rejection temperature. A two-stage Cs-Li system was selected for more detailed design and cost calculations. The efficiency of this system was 13.5% which, when combined with a steam-turbine bottoming cycle, gives an efficiency of 52% in the absence of furnace losses. The design application chosen used a furnace efficiency of 86%, which gave a total plant efficiency of about 45%. It was found that for the estimated 1980 fuel cost for coal (40¢/million BTU) the designed binary plant gave a power cost of 11.2 mill/kw-h vs 11.6 mill/kw-h for the conventional plant. The oil-fired binary system had a lesser cost savings over a conventional oil-fired plant. At a 1980 fuel price of 90¢/million BTU the liquid metal MHD binary plant produced power at a cost of 12.9 mill/kw-h vs 13.1 mill/kw-h for the conventional plant. Foreseeable improvements in cycle conditions, separator performance, and generator performance are discussed. (Auth)

AVAILABILITY: Dr. John Fox, Dept. of Mechanical Engineering, University of Mississippi, University, MS 38677 (\$15.00 for entire proceedings)

Coal fired MHD for central station power generation.
W.D. Jackson (Electric Power Res. Inst., Palo Alto, Calif., USA), R.V. Shank, in: III, 5th Annual Frontiers of Power Technology Conference, Stillwater, Okla., USA, 10-11 Oct. 1973 (Stillwater, Okla., USA: Oklahoma State Univ. 1973), 24/1-17

The ability of the MHD generator to operate at high overall thermal efficiency with combustion gas products which contain particulates and chemical impurities gives it important advantages in the development of high efficiency fossil fired combined cycle systems to meet both air and thermal pollution standards. A coordinated development program is needed to explore the implementation of these advantages and this must include the design and construction of an MHD pilot plant operating with coal as primary fuel. (10 refs.)

TITLE: Evaluation of a Plasma/Liquid Metal MHD Cycle for a Central Station Power Plant
AUTHOR: Cutting, J.C.; Amend, W.E.
CORPORATE AUTHOR: University of Illinois at Chicago Circle; Argonne National Laboratory
ADDRESS: UI, Chicago, IL; ANL, Argonne, IL
PUBLICATION DESCRIPTION: Paper presented at 13th Symposium on the Engineering Aspects of Magnetohydrodynamics, 7 p.
PUBLICATION DATE: 1973

SPONSOR: National Science Foundation
ABSTRACT: Preliminary results of in-depth studies of a MHD cycle consisting of a fossil fired plasma MHD topping cycle and a liquid-metal MHD bottoming cycle are presented. Mathematical models for the open-cycle plasma topping and liquid-metal bottoming cycle were combined to obtain a detailed computer code that simulates realistic operation of the combined cycle. The plasma MHD system burns natural gas in preheated air with potassium seed. The closed liquid-metal loop is a lithium-helium cycle employing a gas turbine to supply the power for gas compression. Results of the study for this cycle are compared with calculations of a plasma MHD/steam cycle for similar operating conditions of topping cycle. It is shown that a potential improvement in performance of up to 10.5% occurs when the liquid-metal bottoming loop is employed. (Auth)

AVAILABILITY: Dr. John Fox, Dept. of Mechanical Engineering, University of Mississippi, University, MS 38677 (\$15.00 for entire proceedings)

N74-16620# Bureau of Mines, Pittsburgh, Pa. Energy Research Center.
AN ECONOMIC EVALUATION OF MHD-STEAM POWER-PLANTS EMPLOYING COAL GASIFICATION
P. D. Bergman, K. D. Plants, J. J. Demeter, and D. Bienstock
1973 37 p refs
(IBM-RI-7796) Avail: NTIS HC \$4.00

To assess the efficacy and economics of producing power from coal, four open-cycle magnetohydrodynamic (MHD) processing schemes were selected for study. Each involved a different mode of coal combustion and level of gas cleanliness. The options considered were: (1) coal burned in a slagging combustor; (2) suspension gasification with slag removal prior to combustion; (3) parallel cyclone combustors, one operating fuel rich and the other operating with excess air; and (4) suspension gasification by the hot exhaust gases from the MHD duct with ash removed prior to combustion. Option 1 has the highest ash content in the combustion plasma and as a result would have the greatest operational difficulties associated with it. Options 2 and 4 have the cleanest MHD combustion plasma. For coal priced at \$4/ton, the power generating cost of Option 4, 11.78 mills/kw-hr, is the highest, with Option 1, at 9.04 mills/kw-hr the lowest. These costs may be compared with a conventional power cost of 9.92 mills/kw-hr for the late seventies. Capital costs of three of the four options were competitive with those of conventional thermal power plants employing stack gas SO₂ cleanup systems. Option 2 has the most favorable combination of operating characteristics and power cost. It was concluded that a clean, high-temperature working fluid can probably be produced from coal without leading to depressed system efficiencies and exorbitant capital cost.

1973

TITLE: Investigation in Energy Transfer and Energy Conversion for Advanced Power and Propulsion Systems
AUTHOR: Calvert, C.; Watson, J.
CORPORATE AUTHOR: Systems Research Laboratories Inc.

ADDRESS: Dayton, OH
PUBLICATION DESCRIPTION: Report No. ARL 73-0122, 109 p., 24 references

PUBLICATION DATE: 1973, October
SPONSOR: U.S. Dept. of Defense, Air Force Systems Command, Aerospace Research Laboratories

ABSTRACT: This report covers the work done in three areas of energy conversion and transfer involving fluid dynamic processes: (1) electrofluiddynamic energy conversion, (2) multicomponent flow research, and (3) aerodynamic energy transfer research. The effort under item one is an exploration of direct energy conversion of fluid dynamic energy into electrical power using electrofluiddynamic (EFD) processes. The objective here is to identify workable and practical processes and designs for superior, lightweight, reliable, electrical generators. Item two above covers studies of methods by which heat energy from reactants of solid particles or droplets contained in a combustion or reaction chamber can be used to produce fluid dynamic energy. The principal objective of this work has been to assess wall erosion, particle suspension, and related fluid dynamic effects. The effort in item three is the exploration of fluid dynamic processes and components germane to practical thrust augmentation ejectors. The objective here is to identify appropriate design concepts applicable to future vertical or shortfield take-off-and-landing aircraft. The work accomplished in the above areas was conducting investigations, supplying experimental test data, and providing support. The results and conclusions of the various studies are contained in topical reports published during the contract period. A list of these reports is included in the Appendix. (Auth)

AVAILABILITY: NTIS

N74-14408# Office of Naval Research, London (England).
MHD FOR POWER GENERATION: THE VIEW OF A CHOSEN FEW

David F. Dyer 20 Apr. 1973 11 p
 (AD-760342: ONRL-C-10-73) Avail: NTIS CSCL 20/9

A report of the ninth meeting of the international liaison group on magnetohydrodynamics power generation and the MHD closed cycle specialist meeting held in Geneva is given. The following topics are discussed various concepts proposed for MHD power generation the role of programs in various countries technology problems to be overcome in producing viable MHD power generation systems meetings and publications concerned with MHD for power generation.

Author (GRA)

1973

PRELIMINARY TESTS OF A 1 MW MAGNETOHYDRO-DYNAMIC GENERATOR. Dogaru, I.; Grecov, D.; Katona, L.; Cserveny, I. Rev. Roum. Sci. Tech., Ser. Electrotech. Energ.; 18: No. 4, 729-742(1973).

A 1 MW(t), magnetohydrodynamic generator designed and constructed at ICPET, Bucharest is described. The MHD-02 generator operates in open circuit with plasma obtained by the combustion of natural gases in preheated air enriched with oxygen. It includes a combustion chamber, an acceleration nozzle, a conversion channel, a diffuser, a scrubber, an air preheater, an electromagnet, a seeding device, an oxygen installation, a water cooling installation, an inverter and a measurement installation. The operation regimes of the subassemblies are described within the preliminary tests of the generator. Also given are the results of measurements in the conversion channel. (auth)

MAGNETOHYDRODYNAMIC POWER GENERATION.

Energy Dig.; 2: No. 4, 22-23(Jul 1973).

A materials program for magnetohydrodynamic power generation at the US National Bureau of Standards is summarized. Initially the research was concentrated on defining the behavior characteristics of construction, insulating and conducting materials that will be used in MHD, and in characterizing the coal slag that may be flowing through the system. Chemical analysis, x-ray diffraction, petrographic examination, differential thermal analysis and Moesbauer spectroscopy methods are used. Information was also collected on vaporization, viscosity and electrical conductivity of the slag. Properties of seed materials are also being studied. (UK)

R. BÜNDE and J. RAEDER, Max-Planck Institut für Plasmaphysik, Garching, Germany.

Designing MHD generator systems for minimum power production costs: Energy Conversion 13, 143-148 (1973).

Summary:—The calculation of the thermodynamic and electrical data, on the one hand, and the power production costs, on the other, of a kerosene-oxygen fired supersonic MHD generator was taken as a starting point to study the influence of the design parameters on the power production costs. The results of this investigation allow optimum design of the MHD power plant as regards power production costs and operational safety.

Key words: Thermodynamic and electrical data power production costs kerosene-oxygen supersonic MHD generator design parameters operational safety

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TITLE: Auxiliary Components: Their Effect on Plant Design Performance and Economics
AUTHOR: Hais, P.; Gannon, R.
CORPORATE AUTHOR: Avco Everett Research Laboratory Inc.
ADDRESS: Everett, MA
PUBLICATION DESCRIPTION: Paper presented at 13th Symposium on the Engineering Aspects of Magnetohydrodynamics
PUBLICATION DATE: 1973
SPONSOR: U.S. Dept. of Interior, Office of Coal Research; Edison Electric Institute
ABSTRACT: The design, performance and economics of open-cycle fossil-fueled central-station MHD power plants are discussed with particular reference to important plant components and items, such as MHD generator performance, air preheat, oxygen enrichment of the combustion air, combustion process and waste heat utilization. (Auth)
AVAILABILITY: Dr. John Fox, Dept. of Mechanical Engineering, University of Mississippi, University, MS 38677 (\$15.00 for entire proceedings)

N73-26749# Naval Postgraduate School, Monterey, Calif.
ELECTROHYDRODYNAMICS (EHD) RESEARCH Final Report, 1971-1972

Oscar Biblarz 12 Feb. 1973 100 p refs
 (AD-759971; NPS-572173021A) Avail: NTIS CSCL 20/9

The report contains further considerations of the slip parameter for unsteady flow. Several important gas/particle combinations are represented and conclusions regarding electrical efficiency are given. Also, a computer study which solves the combined Laplace/Poisson equations for geometries representing the EHD channel is included. This program is used to predict the effect of voltage scheduling electrodes, and the predictions are checked out experimentally.

Author (GRA)

N74-18723# Joint Publications Research Service, Arlington, Va.
THERMAL CYCLE AND EFFICIENCY OF A VERSATILE POWER UNIT WITH A MAGNETOHYDRODYNAMIC GENERATOR AND THERMOELECTRIC GENERATOR
 V. A. Kirillin, A. Ye. Sheyndlin, Ye. M. Shelkov, Ye. V. Shishkov, S. A. Pashkov, and V. M. Latyshev 1 Mar. 1974 8 p refs
 Transl. into ENGLISH from Teplofiz. Vysokikh Temperatur, Akad. Nauk SSSR (Moscow), v. 11, no. 5, 1973 p 1088-1091 (JPRS-61359) Avail: NTIS HC \$4.00

A MHD generator circuit is described with an overload mode capacity making operation possible in a wide range of loads.

Author

N74-11862# ARO, Inc., Arnold Air Force Station, Tenn.
DEVELOPMENT OF DESIGN CRITERIA, COST ESTIMATES, AND SCHEDULES FOR AN MHD HIGH PERFORMANCE DEMONSTRATION EXPERIMENT Final Report, Apr. 1972 - Apr. 1973

G. W. Garrison, T. R. Brogan, H. J. Schmidt, and J. J. Nolan
 AEDC Aug. 1973 119 p refs Sponsored by Office of Coal Res.

(ARO Proj. PF228)
 (AD-766232; ARO-PWT-TR-73-75; AEDC-TR-73-115) Avail: NTIS CSCL 10/2

The successful application of magnetohydrodynamics (MHD) for commercial, coal-fired, base-load power generation requires that the generator have an energy extraction ratio of approximately 0.20 with a turbine efficiency of 70 percent. There is a significant gap between this required performance and the generator performance which has been achieved to date. The commercial MHD concept is critically dependent upon the generator achieving this required performance, and it is therefore essential that a demonstration of this generator performance have the highest priority. Of equal importance, the generator channel configuration and operating conditions which are necessary in order to achieve the required performance will be determined while accomplishing the performance demonstration. Thus other Office of Coal Research (OCR) sponsored MHD research efforts can be directed toward the real problems and configurations as determined by solid experiments. (Modified author abstract) GRA

TITLE: Economic Leverage Points of Open Cycle Magnetohydrodynamic Power Systems

AUTHOR: Oliver, D.A.

CORPORATE AUTHOR: Massachusetts Institute of Technology

ADDRESS: Cambridge, MA

PUBLICATION DESCRIPTION: Paper presented at 13th Symposium on the Engineering Aspects of Magnetohydrodynamics, 3 p.

PUBLICATION DATE: 1973

ABSTRACT: The importance of powerplant capital investment costs in the past and in the near future in controlling energy production costs is pointed out. The leverage which an advanced fossil fuel system such as the MHD/steam cycle can bring to bear on plant capital costs is examined in two key areas: diminished capital costs due to diminished cooling tower requirements for high efficiency MHD and the capability of the MHD/steam plant to utilize sulfur bearing fuels without the added cost of desulfurization. These advantages are compared to alternative fossil fuel systems including conventional steam plants and combined gas turbine/steam plants. It is shown that significant reduction of the MHD system capital costs over conventional steam plants may be required to give MHD/steam plants a strong advantage over combined cycle systems. (Auth)

AVAILABILITY: Dr. John Fox, Dept. of Mechanical Engineering, University of Mississippi, University, MS 38677 (\$15.00 for entire proceedings)

N74-16815# Systems Research Labs., Inc., Dayton, Ohio.
KIVA-1 MHD GENERATOR MODIFICATIONS AND TESTS
 Technical Report, 28 Feb. 1972 - 31 Mar. 1973
 Lester W. Buechler and Robert A. Nimmo Aug. 1973 241 p
 refs

(Contract F33615-71-C-1425)

(AD-770063; AFAPL-TR-73-71) Avail: NTIS CSCL 10/2

The AFAPL-MHD Facility (KIVA-1) was used to conduct an extensive series of tests on the pegwall diagonally connected generator. Extensive knowledge was gained in the areas of conductivity, oxygen-to-fuel ratios, interelectrode connection angles, seed particle geometry, and optimum loading conditions. A peak power of 210 KW was achieved. A DC-to-DC inverter was successfully operated on the MHD generator, providing an output of 50 KW at 50 KV dc. Numerous modifications were made to the KIVA-1 facility, including a new high-speed data acquisition system, a close circuit television system, a pulse-control network for the main burner, a new set of pole faces for the magnet, a digital display panel, and an instrumented copper electrode assembly. Author (GRA)

ENERGY FROM ELECTROGASDYNAMICS. Musgrove, P. J. (Univ. of Reading, Eng.). *Electron. Power*, 19: No. 14, 337-339 (9 Aug 1973).

Electrogasdynamics (EGD), a technique for generating electrical power directly from a moving gas stream, is reviewed. An important characteristic of proposed EGD energy-conversion systems is the absence of any mechanical moving parts. Instead, use is made of the interaction between a stationary electric field and charged particles which are swept through the field by a moving gas stream. Single stage and multistage EGD expanders are shown schematically. Efficiency problems are discussed. In the existing ambient-pressure EGD generator at Reading an isentropic efficiency (the ratio of the useful power output to the sum of the useful power output and the power losses) of 53% is theoretically possible whereas the maximum efficiency so far achieved is 12%. Using a multistage EGD expander with reheat, the Ericsson cycle, one can expect to convert heat to electricity at an overall efficiency of about 42%. The range of applications of the EGD system is discussed with especial reference to the field of low temperature refrigeration. (UK)

Designing MHD generator systems for minimum power production costs. R. Bunde, J. Reider (Max-Planck-Inst. Plasmaphys., Garching, Germany). *Energy Convers. (GB)*, vol. 13, no. 4, p. 143-8 (Dec. 1973). The decision whether kerosene-oxygen fired MHD generator systems can be used for short-period reserve power production in public utilities or as emergency power supply in high-capacity nuclear power stations is largely governed by the costs of the power produced by the system. The choice of design parameters therefore has to be based on the need to minimize the power cost under the given conditions. These parameters are determined. (4 refs.)

N74-13466*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.

LIQUID METAL MAGNETOHYDRODYNAMICS (LMMHD) TECHNOLOGY TRANSFER FEASIBILITY STUDY. VOLUME 1: SUMMARY

R. L. Phen, Lance G. Hays, and M. E. Alper 18 May 1973
 60 p Sponsored by NASA 2 Vol.
 (NASA-CR-136197; JPL-1200-59-Vol-1) Avail: NTIS HC \$5.00 CSCL 201

The potential application of liquid metal magnetohydrodynamics (LMMHD) to central station utility power generation through the period to 1990 is examined. Included are: (1) a description of LMMHD and a review of its development status, (2) LMMHD preliminary design for application to central station utility power generation, (3) evaluation of LMMHD in comparison with conventional and other advanced power generation systems and (4) a technology development plan. One of the major conclusions found is that the most economic and technically feasible application of LMMHD is a topping cycle to a steam plant, taking advantage of high temperatures available but not usable by the steam cycle.

Author

N74-13467*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.

LIQUID METAL MAGNETOHYDRODYNAMICS (LMMHD) TECHNOLOGY TRANSFER FEASIBILITY STUDY. VOLUME 2: APPENDIXES

R. L. Phen, Lance G. Hays, and M. E. Alper 18 May 1973
 198 p refs Sponsored by NASA 2 Vol.
 (NASA-CR-136198; JPL-1200-59-Vol-2) Avail: NTIS HC \$12.00 CSCL 201

For abstract, see N74-13466.

MHD POWER GENERATION.

R.J. Rosa.

IEEE Trans. Plasma Science, v.PS-1, no.1, Mar.73.

The MHD conversion process is discussed and compared with the operation of a plasma fusion reactor. The potential advantages of the MHD generator over a turbine for the conversion of heat into a more useful form of energy are also pointed out. (1 refs.)

73-WA/Ener-3 ■ Magnetohydrodynamics-Low Air Pollution Power Generation, by D. Benstock, Mem. ASME, P. D. Bergman, J. M. Henry, R. J. Demski, J. J. Demeter, U. S. Bureau of Mines, Pittsburgh Energy Research Center, Pittsburgh, Pa., and K. D. Plants, U. S. Bureau of Mines, Morgantown, W. Va.

In this era of energy shortage and increased environmental restraints, coal-fired MHD power generation offers a promising option to ameliorate these problems. It has very low pollution potential. Emissions of SO_2 are practically eliminated.

Costs of removing SO_2 from a 1000-MWe MHD-steam plant are calculated to be \$10.4/kw, approximately 1/4 of that for conventional coal-fired power plants. Seed makeup costs are marginal even at potassium recoveries as low as 95 percent. Through use of two-stage combustion, NO_x emissions were reduced to 150 ppm or 0.12 lb NO_2 /million Btu, well below EPA regulations.

Capital investment for such a two-stage combustion, MHD-steam power plant is about 10 percent lower than for a single-stage combustion plant.

73-WA/Ener-10 ■ Development and Design Characteristics of Auxiliary MHD Power Plant Components, by F. Hals, and R. Gannon, Avco Everett Research Laboratory, Inc., Everett, Mass.

The development work on important auxiliary components for MHD power plants with coal as the fuel source is described. Items included are air heaters, combustion systems including those for conversion of coal to a clean fuel before combustion, seeding techniques, and methods of gas cleaning for air pollution control of the effluent gas.

Design criteria and operating characteristics of the different plant components are discussed along with relationship to overall plant design, performance, environmental aspects, and economics.

73-WA/Ener-2 ■ Direct Coal Fired MHD Power Generation, by J. B. Dicks, L. W. Crawford, & K. W. Kornstett, University of Tennessee Space Institute, Tullahoma, Tenn. (To be published in Trans. ASME—J. of Engrg. for Power.)

This paper describes the results of the first experiments in the operation of a magnetohydrodynamic (MHD) generator on coal at simulated central power conditions. The microscopic examination of the generator after one hour of operation shows no damage to any of the electrode or insulator structures.

The relations between these experiments and the full-scale central power direct coal fired plant are discussed along with the problems that have been solved and those that still remain to be solved before this technology can be put into application.

73-WA/Ener-9 ■ MHD Generator Experimental Activity at Avco Everett Research Laboratory, Inc., by R. Rosa, S. Petty, J. Klepers, and O. Sonju, Avco Everett Research Laboratory, Inc., Everett, Mass.

The MHD generator is now recognized as offering one of the more promising possibilities for substantially increasing the efficiency of thermal to electric energy conversion, together with advantages of scale, quick response, and adaptability to all fuels regardless of ash content. Also of increased importance are its advantages with respect to environmental impact.

These features of MHD are discussed in more detail along with a discussion of the development program on MHD plant auxiliary components, in a companion paper (F. Hals and R. Gannon).

In this paper the test program currently underway at AERL, Inc., on the MHD generator itself is described.

1973

1973

N74-10948# General Electric Co., Philadelphia, Pa. Space
Div.
**CLOSED CYCLE MHD FOR CENTRAL STATION POWER
WITH FOSSIL OR NUCLEAR FUELS**
Bert Zauderer, Charles H. Marston, and Charles S. Cook Aug.
1973 48 p refs
(Contract N00014-73-C-0039; AF Proj. 9800)
(AD-766500; Rept-73SD231; ONR-TR-20) Avail: NTIS CSCL
10/2

A closed cycle MHD generator using a noble gas with alkali
metal vapor as the working fluid, when used as a topping unit
for a conventional steam plant, can yield cycle efficiencies in
excess of 80% at peak stagnation temperature of 3000F. While
high enough for substantial gains in thermodynamic efficiency,
this temperature is relatively low for an electrically conducting
gas and conductivity is achieved by decoupling electron tempera-
ture from gas temperature. A ceramic regenerative heat exchanger
supplies thermal energy to the working fluid. The latter can be
any clean fossil fuel, preferably low BTU (about 150 BTU/SCF)
coal gas. With multi-stage combustion, pulverized coal is also
a possible fuel. On a long range basis, closed cycle MHD is
ideally suited for high temperature gas cooled fission reactors
and probably also to fusion reactors. The closed cycle MHD
generator is adaptable to the Brayton cycle, the regenerative
Brayton cycle and eventually the Rankine cycle. Author (GRA)

CONGRESS GETS STATUS REPORT ON MHD POWER GENERATION.
(Second part of Energy Digest's coverage of House
hearings on MHD. research.)

Energy Digest, July 16, 1973, p.316-319.

**MAGNETOHYDRODYNAMIC POWER: MORE EFFICIENT USE OF
COAL.** A.L. Hammond.

Science, v.178, no.4059, Oct.27,1972, p.386-7.

It is noted that MHD generators offer a method
of eliminating sulfur oxides and reducing nitrogen
oxides emissions from coal fired plants.

N73-31996# Air Force Systems Command, Wright-Patterson
AFB, Ohio. Foreign Technology Div.
**MAGNETOHYDRODYNAMIC GENERATOR FOR A COM-
BINED MAGNETOHYDRODYNAMIC ELECTRIC POWER
PLANT WITH A FIRST GENERATION OPEN CYCLE**
B. Ya. Shumyatski, M. G. Koryagina, P. P. Ivanov, and V. I.
Kovbasyuk 31 Jul. 1973 28 p refs Transl. into ENGLISH
from unidentified Russian monograph
(AF Proj. 3145)
(AD-764925; FTD-MT-24-713-73) Avail: NTIS CSCL 10/2

Contents: Preliminary analysis of the best magnetic systems;
Variation problem in the technical and economical optimization
of an MHD generator; Characteristics of optimum MHD
generators.

**THERMODYNAMIC DATA FOR AIR
PREHEATERS IN DIRECT COAL-FIRED MAG-
NETOHYDRODYNAMIC POWER GENERATION
SYSTEMS.** Calculated equilibrium data are presented
for three phases in the flue gas stream from a hypotheti-
cal open cycle MHD generator. A typical coal is
"burned" with 1.0 gram-mole K_2O seed per kilogram
coal and with 101 percent of stoichiometric air. Tables
of composition and the over thermodynamic properties,
enthalpy and entropy, are given for the temperatures
2200 (-100) 1100 kelvins, pressures 1.0 and 1.5
atmospheres, and slag rejection figures of 90 and 75
percent. 4 refs.

Spencer, F.E. Jr. Pittsburgh Energy Res. Cent. Pre-
Headline J.C. Jr. *US Bur Mines Inf Circ* a 8611 1973
33 p.

(AD-766493-1) INVESTIGATION OF A NONEQUI-
LIBRIUM MHD GENERATOR. Annual Report, 1 August 1972-
31 July 1973. Zauderer, B. (General Electric Co., Philadelphia,
Pa. (USA)). Aug 1973. Contract N00014-73-C-0039. 33p.
NTIS \$3.00.

The report presents research results on the following: the ST-
40 MHD channel; the 4 Tesla magnet for the ST-40 MHD channel;
MHD generator theoretical analyses; Gas dynamic performance,
ST-40 channel; MHD generator performance, ST-40 channel; and
gas dynamic performance. (auth)

636

TK2896, I55 1973

TITLE: Exploratory Study of Several Advanced Nuclear-MHD Power Plant Systems
AUTHOR: Williams, J.R.; Rosa, R.J.; Yang, Y.Y.; Clement, J.D.

CORPORATE AUTHOR: Georgia Institute of Technology

Technology: AVCO-Everett Research Laboratory

ADDRESS: GA Tech., Atlanta, GA 30332

PUBLICATION DESCRIPTION: Paper 739017 presented at 8th Intersociety Energy Conversion

Engineering Conference held at University of Pennsylvania, Philadelphia, PA, Aug. 13-17,

1973, p. 558-564 of Proceedings, 21 references

PUBLICATION DATE: 1973

SPONSOR: National Aeronautics and Space Administration, Lewis Research Center

ABSTRACT: In order for efficient multi-megawatt closed cycle nuclear-MHD systems to become practical, long-life gas cooled reactors with exit temperatures of about 2500 degrees K or higher must be developed. Four types of nuclear reactors which have the potential of achieving this goal are the NERVA-type solid core reactor, the colloid core (rotating fluidized bed) reactor, the "light bulb" gas core reactor, and the "coaxial flow" gas core reactor. Research programs aimed at developing these reactors have progressed rapidly in recent years so that prototype power reactors could be operating by 1980. Three types of power plant systems which use these reactors have been analyzed to determine the operating characteristics, critical parameters and performance of these power plants. Overall thermal efficiencies as high as 80% are projected using an MHD turbine-compressor cycle with steam bottoming, and slightly lower efficiencies are projected for an MHD motor-compressor cycle. Nuclear analyses of several reactor configurations have shown that these reactors are capable of breeding, that is, they can produce more fissile fuel than is used. Applications of these plants include terrestrial power generation, space power in the multimegawatt range, and power for proposed satellite nuclear power stations. (Auth)

AVAILABILITY: American Institute of Aeronautics and Astronautics, Order Dept., 1290 Avenue of the Americas, New York, NY 10019 (\$60.00 for entire proceedings)

QC 809.M3593 1972

APPRAISAL OF COAL-GASIFICATION SCHEMES FOR MHD POWER GENERATION. Bergman, P. D.; Plants, K. D.; Denster, J. J.; Bisenstock, D. (Pittsburgh Energy Research Center). pp VI.3.1-VI.3.7 of Engineering Aspects of Magnetohydrodynamics. Petrick, M. (ed.). Argonne, IL; Argonne National Lab. (1972).

From 12th symposium engineering aspects of magnetohydrodynamics; Argonne, IL (27 Mar 1972). See CONF-720342.

To assess the efficacy and economics of producing power from coal four open-cycle MHD processing schemes were selected for study. Each involved a different mode of coal combustion and level of gas cleanliness. The options considered were: (1) coal burned in a slagging combustor; (2) suspension gasification with slag removal prior to combustion; (3) parallel cyclone combustors operating fuel rich and with excess air; and (4) gasification by the hot exhaust gases from the MHD duct with ash removed prior to combustion. Option 1 has the highest ash content in the combustion plasma and as a result would have the greatest operational difficulties associated with it. Options 2 and 4 have the cleanest MHD combustion plasmas. The power generating cost of Option 4,

QC 809.M3592 1972

PRODUCTION OF CLEAN WORKING FLUID FOR COAL BURNING, OPEN-CYCLE MHD POWER GENERATION. Lacey, J. J.; Demeter, J. J.; Bisenstock, D. (Pittsburgh Energy Research Center). pp VI.2.1-VI.2.5 of Engineering Aspects of Magnetohydrodynamics. Petrick, M. (ed.). Argonne, IL; Argonne National Lab. (1972).

From 12th symposium engineering aspects of magnetohydrodynamics; Argonne, IL (27 Mar 1972). See CONF-720342.

A preliminary process design is presented for a three-stage high-temperature coal combustion pilot plant capable of producing a hot, relatively ash-free combustion gas suitable for open-cycle MHD power generation. The system will operate at 8.0 atmospheres and consists of a 1st stage vertical cyclone gasifier, a 2nd stage fluid bed CO₂ reformer, and a 3rd stage vertical cyclone combustor. Pulverized coal is fed to the 1st and 2nd stages, and preheated air to the 1st and 3rd stages. Gasifier temperature is controlled with recycle flue gas which indirectly minimizes overall system heat losses. The design was based on a typical Pittsburgh seam of high-voltage bituminous coal and indicated that the product gases would leave the combustion system at 4300°F, retaining less than 10% of the input coal ash. (Auth)

1972

TK Intersociety Energy Conversion Engineering
 Conference, 7th, San Diego, Calif., 1972.
 2896
 1-55 Proceedings. Washington, D. C., American
 1972 Chemical Society, 1972.
 1533 p. illus. 28 cm.

Feasibility of Utilizing MHD for Powering High-Speed Land Vehicles
 J. J. Lacey, F. E. Spencer, J. J. Demeter, D. Blenstock. 1022

Hall Current Effects in the Lewis Magneto-hydrodynamic Generator
 L. D. Nichols, R. J. Sovie 1125

Slip Parameter for Electrogasdynamical Generators with Unsteady Flow, O. Biblitz. 1169

Exploratory Investigation of an Electric Power Plant Utilizing a Gaseous Core Reactor
 with MHD Conversion, J. R. Williams, Y. Y. Yung, K. D. Kirby, J. D. Clement 1305

1972

Open Cycle Coal Burning MHD Power Generation—
 An Assessment and a Plan for Action (Revision of OCR
 R&D Report No. 64)
 Issued August, 1972
 R&D Report No. 71
 Contractor: Massachusetts Institute of Technology
 Refer to: Titled report and GPO Catalog No. 163.10:71
 Price: \$1.50

Magnetohydrodynamic Power Generation with the
 Combustion Products of Char
 Issued January, 1972
 R&D Report No. 65—Interim Report No. 1
 Contractor: University of Tennessee Space Institute
 Refer to: Titled report and GPO Catalog No. 163.10:65/
 Int. 1
 Price: \$0.75

NONLINEAR INTERNAL RESISTANCE OF AN EGD
 GENERATOR. Malaczynski, G. W. Pr. Inst. Masz. Przeply.:
 58: 3-9(1972).
 An electrodynamic generator model is presented in which
 account is taken of the influence of the outlet section of the pro-
 cess in the region of conversion. By formulating appropriate
 boundary conditions for the selected generator model, it was pos-
 sible to determine nonlinear internal resistance of the generator
 as a function of flow parameters and the model geometry. (Appl.
 Mech. Rev.)

N73-14746# Bureau of Mines, Pittsburgh, Pa. Energy Research
 Center.
 EXPERIMENTAL INVESTIGATIONS OF AN OPEN-CYCLE,
 VORTEX MHD GENERATOR
 George J. Conroy, Roy Kurtzrock, C. Richard B. Sneedden, Joseph
 J. Demeter, Daniel Blenstock, and William F. Hughes (Carnegie-
 Mellon Univ.) 1972. 31 p. refs
 (IBM-RI-7699) Avail: NTIS HC \$3.75

Electrical power generation was studied in a laboratory scale,
 open-cycle vortex MHD generator, which offers several advantages
 over straight channel generators that require separate combustors.
 Compactness, lower capital cost, and high energy release are
 obtained by combining the combustor and generator into one
 unit in the vortex generator. In addition, the vortex generator
 uses a simple solenoid rather than the more complex and expensive
 saddle magnet required for straight channel generators. The
 primary motivation for this experimental device in terms of ultimate
 objective was to investigate the vortex generator with applications
 to direct coal firing and with combustion taking place in specially
 designed expansion nozzles. The vortex device offers one
 decided advantage over the linear device in this regard because
 slag deposits do not degrade or short-circuit the coaxial electrodes
 as is the case for a linear machine. Power was obtained by
 impressing an axial field of 3,000 G from an air core solenoid
 magnet. Tests were conducted by seeding natural gas seeded
 with potassium acetate and burning with preheated oxygen
 enriched air. Power generation was lower than calculated because
 theoretical plasma velocities were not achieved. Author

1972

638

N73-16887# Joint Publications Research Service, Arlington, Va.
MAGNETOHYDRODYNAMIC METHOD OF PRODUCING ELECTRICAL ENERGY, PART 1
 V. A. Kirilin, ed. and A. Ye. Sheyndlin, ed. 9 Jan. 1973 207 p
 refs. Transl. into ENGLISH of the book "Magnitogidrodinamicheskiy Metod Polucheniya Elektroenergii" Moscow, Energiya, 1972 360 p
 (JPRS-57940-1-Pt-1) Avail: NTIS HC \$12.50

A collection of articles on magnetohydrodynamic energy generation is presented. The topics discussed are: (1) the theory and calculation of flows in a MHD generator operating on an equilibrium plasma, (2) experimental investigation of open-cycle MHD generators, (3) investigations of the physical processes and diagnostics in open- and closed-cycle MHD generators, (4) investigations of the basic equipment of MHD generators, (5) investigations of circuits and cycles of power stations with MHD generators, (6) liquid-metal MHD plants, and (7) material for MHD generators. Author

N73-16888# Joint Publications Research Service, Arlington, Va.
MAGNETOHYDRODYNAMIC METHOD OF PRODUCING ELECTRICAL ENERGY, PART 2
 V. A. Kirilin, ed. and A. Ye. Sheyndlin, ed. 9 Jan. 1973 209 p
 refs. Transl. into ENGLISH of the book "Magnitogidrodinamicheskiy Metod Polucheniya Elektroenergii" Moscow, Energiya, 1972 360 p
 (JPRS-57940-2-Pt-2) Avail: NTIS HC \$12.50

A collection of articles on magnetohydrodynamic energy generation is presented. The topics discussed are: (1) the theory and calculation of flows in a MHD generator operating on an equilibrium plasma, (2) experimental investigation of open-cycle MHD generators, (3) investigations of the physical processes and diagnostics in open- and closed-cycle MHD generators, (4) investigations of the basic equipment of MHD generators, (5) investigations of circuits and cycles of power stations with MHD generators, (6) liquid-metal MHD plants, and (7) material for MHD generators. Author

N73-25102# Bureau of Mines, Washington, D.C.
ECONOMICS OF MIXED POTASSIUM-CESIUM SEEDING OF AN MHD COMBUSTION PLASMA

P. D. Bergman and D. Binstock Dec. 1972 17 p refs
 (PB-214314/7; BM-R1-7717) Avail: NTIS HC \$3.00 CSCL 10B

The proposed use of cesium seeded combustion plasmas for open-cycle MHD power generation has attracted considerable interest. Cesium-seeded combustion plasma exhibits a greater electrical conductivity than a potassium-seeded combustion plasma. However, there are drawbacks to cesium seeding such as: the need to use low sulfur coal because of cesium's inability to effectively remove SO₂ from the combustion products; the high cost of the cesium ore, pollutant; and cesium's limited availability. Thus, the report looks at the alternative of using a mixture of both potassium and cesium for seeding to overcome these problems. Costs and techniques are also briefly discussed. GRA

A72-16936* # Status of power generation experiments in the NASA Lewis closed-cycle MHD facility. R. J. Sovie and L. D. Nichols (NASA, Lewis Research Center, Plasma Power Generation Section, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 10th, San Diego, Calif., Jan. 17-19, 1972, Paper 72-103*, 8 p. 8 refs. Members, \$1.50; non-members, \$2.00. *see also* **N72-12166 #**

In this paper the design and operation of the closed-cycle MHD facility is discussed and results obtained in recent experiments are presented. The main components of the facility are a compressor, recuperative heat exchanger (preheater), heater, nozzle, MHD channel with 28 pairs of thoriated tungsten electrodes, cesium condenser, and an argon cooler. The heater can supply 1.1 MW of thermal power to a 2.27 kg/sec gas stream. The facility has been operated at temperatures up to 2100 K with a cesium-seeded argon working fluid. At low magnetic field strengths ($B = 0.2$ T), the open circuit voltage, Hall voltage and short circuit current obtained are 90, 69, and 47 percent of the theoretical equilibrium values, respectively. The Hall voltage and short circuit current decrease sharply with increasing magnetic field strength, however. Comparison of these data with a wall and boundary layer leakage theory indicates that the generator has shorting paths in the Hall direction. (Author)

A72-29351 Symposium on the Engineering Aspects of Magnetohydrodynamics, 12th, Argonne, Ill., March 27-29, 1972, Proceedings. Symposium sponsored by the Argonne National Laboratory and University of Illinois. Edited by M. Petrick (Argonne National Laboratory, Argonne, Ill.). University, Miss., University of Mississippi, 1972 376 p. \$15.

The papers are short reports dealing with work currently in progress. These include studies of nonequilibrium generators, combustion generators, plasma properties and diagnostics, liquid-metal MHD, plasma instabilities, MHD components, and system studies.

N73-23768# Avco-Everett Research Lab., Everett, Mass.
EXPERIMENTAL AND ANALYTICAL RESEARCH ON A TWO MEGAWATT, HIGH PERFORMANCE MHD GENERATOR
 Interim Report, 1 Apr. 1971 - 1 Oct. 1972
 O. K. Sonju and J. Teno Oct. 1972 341 p
 (Contract F33615-71-C-1456; AF Proj. 3145)
 (AD-758489; AFAPL-TR-72-98) Avail: NTIS CSCL 10/2

The report presents the initial results of a combined analytical and experimental program whose broad objectives are to achieve a more complete understanding of the operation and appropriate design techniques of compact high-performance MHD generators by further establishing the detailed analytical basis of the performance of these generators and to demonstrate the feasibility of operating compact high-performance MHD generators under a repetitively pulsed mode of operation at high power levels in this case at the 2 MW level. In particular, the results of studies of stability, and effects, transient response, diagnostic, rapid startup, channel voltage breakdown and performance optimization are discussed and summarized. A parallel effort under this program has been directed to constructing a generator test facility and designing and fabricating a 2 MW high-performance MHD generator system to be used in the test facility. Author (GRA)

MHD CENTRAL POWER: A STATUS REPORT.

J.B. Dicks, Univ. Tennessee.
Mechanical Engineering, v.94, no.5, May 1972, p.14-20.

MHD ELECTRICAL POWER GENERATION: 1972 STATUS REPORT.
ATOMIC ENERGY REVIEW, v.10, no.3, 1972, p.302-377.

by Joint ENEA/IAEA International Liaison Group
on MHD Electrical Power Generation.

PROBLEMS IN MHD ENERGY CONVERSION. A REVIEW.

S.A. Medin, et al.
High Temperature, v.10, no.2, Mar./Apr.1972, p.390-410.

MHD: HIGH PROMISE, UNSOLVED PROBLEMS.

D.E. Thomsen.
Science News, v.102, Aug.26,1972, p.138-140.

N73-25106# Systems Research Labs., Inc., Dayton, Ohio.
CONSTRUCTION AND TEST OF AN MHD GENERATOR CHANNEL AND ELECTRICAL POWER CONVERTER
Technical Report, 1 Feb. 1971 - 28 Feb. 1972
R. Nimmo, L. Buechler, and K. Irish Nov. 1972 166 p refs
(Contract F33615-71-C-1425; AF Proj. 3145)
(AD-758783; AFAPL-TR-73-5) Avail: NTIS CSCL 10/2

The AFAPL MHD Facility was placed in operation. A peg wall, diagonally connected MHD channel was constructed, making use of materials evaluated in a Hall channel. Seed handling procedures, a new seeding wheel, and timing relations for the burner, fuel flow, oxygen flow, and seed injection were developed. A series of conductivity tests were conducted, and a conductivity of 10 mho's per meter was established. The MHD generator was run at an output of 800 volts, 125 kW with a 2.2 Tesla magnetic field strength. A 2000 Hz converter was designed, constructed and tested to convert a 600 volts dc input to a 50,000 volts ac output. The MHD generator was operated successfully with the new channel for 15 runs of 4 to 6 seconds each, with no appreciable deterioration of the MHD channel or support equipment.

Author (GRA)

FIRST PLASMA POWER PLANT IN OPERATION.

Sheldyln, A. (Inst. of High Temperatures, Moscow). Curr. Eng. Pract.; 15: No. 4, 14(Oct 1972).

The principle on which MHD generators are based is explained in brief. The economic and other advantages of using plasma as the conductor in an MHD generator for the production of electricity is brought out by comparing this technique with other conventional ones. It is reported that power plants employing this method can turn 50 to 60% of the heat consumed into electricity, i.e., 50% more output with the same input of fuel, as compared to the other methods. The working of the U-25 power plant in the USSR, which operates on the above principle, is described. A brief mention is made of the success of this plant which has led the USSR to launch a future plan of having many more such MHD generators for coping with the sharp power-consumption peaks in power grids in the country. (INIS)

N73-30899# Kernforschungsanlage, Juelich (West Germany). Inst. fuer Technische Physik.

APPLIED MAGNETOHYDRODYNAMICS. VOLUME 11: OUTLOOK AND POSSIBILITY FOR MHD GAS COMBUSTION GENERATORS WITH AIR TURBINE FOR NUCLEAR PLANT APPLICATION IN THE BRD

G. Noack Oct. 1972 155 p refs In GERMAN (JUL-892-TP-Vol-11) Avail: AEC Depository Libraries \$9.75

Based on the present and on the projected energy needs of West Germany, MHD generators with gas fuel are analyzed. The analysis considers natural gas and air enriched with oxygen to obtain the high temperatures required by the MHD generator. Data about high flame temperatures are listed and discussed in detail. Under the conditions prevailing in West Germany, the best arrangement is offered by an MHD generator with subsequent air turbine. The design of such an arrangement is discussed thoroughly from the technical as well as the structural point of view.

NSA

Open Cycle Coal Burning MHD Power Generation
Issued November, 1971

R&D Report No. 64—Final Report

Contractor: Massachusetts Institute of Technology
Refer to: Titled report and GPO Catalog No. 163.10:64
Price: \$1.25

N71-36450* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
COMBINED TURBINE-MAGNETOHYDRODYNAMIC BRAYTON CYCLE POWER SYSTEM FOR SPACE AND GROUND USE

Lester D. Nichols. Washington. Oct. 1971. 48 p. refs

(NASA-TN-D-6513; E-6442) Avail: NTIS CSCL 10A

A combined turbine-MHD generator operating in a Brayton cycle with a NERVA nuclear reactor is considered, both for use in space and on the ground. The combined system is compared with an all-MHD Brayton system and an all-turbine system. The combined cycle systems have higher thermodynamic efficiencies than the other systems. The combined system with 1500 K turbine inlet and the all-MHD system with generator efficiency of 0.8 have the lowest specific recuperator plus radiator mass of these systems considered. But the combined system considered has an average radiator temperature of 200 to 250 K lower than the other. For ground use, a cycle efficiency of greater than 0.55 can be achieved.

Author

N71-33661* Avco-Everett Research Lab., Everett, Mass.
MHD POWER GENERATION: STATE OF THE ART AND PROSPECTS FOR ADVANCED NUCLEAR APPLICATIONS

Richard J. Rosa. In Florida Univ. Res. on Uranium Plasmas and Their Technol. Appl. 1971. p. 315-326. refs

Avail: SOD\$3.75; NTIS CSCL 18E

State-of-the-art developments in magnetohydrodynamic power generation are reviewed. Base load, emergency, and peaking power generation are included. Economic and environmental factors are considered in relation to MHD generator location. Applications of MHD generators in radiating power plants, propellant-cooled propulsion systems, and commercial industries are cited.

J.M.

A71-40020 MHD power generation. William D. Jackson (Avco Everett Research Laboratory, Everett, Mass.). *Zeitschrift für Flugwissenschaften*, vol. 19, Aug.-Sept. 1971, p. 380-390. 38 refs.

The direct conversion of heat into electricity by means of the interaction between a flowing, electrically conducting fluid and a magnetic field has been the subject of intensive investigation in several countries for the past fifteen years. The motivation for this work has been, and continues to be, the improvement of the efficiency and performance of thermal-electric power plants. This paper reviews the basic principles of magnetohydrodynamic (MHD) power generation and reviews the status of the field as of the beginning of 1971. While emphasis is placed on open cycle MHD systems, other types are briefly described, and the environmental aspects of MHD are discussed.

(Author)

N72-23064/ Aerospace Research Labs., Wright-Patterson AFB, Ohio.

DESCRIPTION OF A HIGH PRESSURE ELECTROFLUID DYNAMIC (EFD) FACILITY Final Scientific Report
 Theodore L. Wilkie and Ernest F. Fretter. Nov. 1971. 59 p. refs (AF Proj. 7116)

(AD-737380; ARL-71-0260) Avail: NTIS CSCL 10/2

A facility is described which simulates EFD generator operation using high pressure air as the working fluid. The humidity, temperature, mass flow, and pressure of the air can be controlled and monitored in two nearly identical air systems. The working fluid is supplied to one of three high pressure test stands enclosing experimental EFD conversion channels. Excitation voltage of up to 150 KV and generate voltages up to 2000 KV are supplied. Types and specifications of various types of instruments are described as well as the types of experiments performed.

Author (GRA)

N73-31848/ Army Foreign Science and Technology Center, Charlottesville, Va.

DEVELOPMENT AND INVESTIGATION OF HIGH TEMPERATURE COMBUSTOR TO BE USED FOR A SOLID FUEL MHD GENERATOR AND THERMODYNAMIC ANALYSIS OF COMBUSTION CONDITIONS

S. A. Tager. 13 Mar. 1973. 16 p. refs. Transl. into ENGLISH from the publ. "5th International Conference on MHD Analysis of Combustion Conditions". Munich, Apr. 1971. 15 p (AD-784153; FSTC-HT-23-2007-72) Avail: NTIS

The basic principles of the high-temperature combustion of natural solid fuel are formulated. Variants are optimized; the scheme of a vertical cyclone with lower gas discharge, hardened slag lining protection of walls, and side removal of slag was adopted. Complete preliminary mixing of dry coal dust with all the high-temperature heated air and uniformly distributed feed of a ready dust-air mixture along the entire cyclone perimeter were carried out. A revised method of calculating high-temperature regimes for the combustion of solid fuel is presented that takes into account the actual operating conditions of the combustion chamber. The maximum attainable temperatures in the combustion of natural fuel were estimated. The combustion chamber, methods and conditions of the experiments are described. (Modified author abstract)

GRA

A71-30716* # The potential of nuclear MHD electric power systems. G. R. Seikel and L. D. Nichols (NASA, Lewis Research Center, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Joint Specialist Conference, 7th, Salt Lake City, Utah, June 14-18, 1971, AIAA Paper 71-638*. 11 p. 19 refs. Members, \$1.50; nonmembers, \$2.00.

MHD generators are uniquely capable of fully exploiting advances in high-temperature reactor technology for electric power generation. Extension of NERVA technology could make 2500 K long-life inert-gas-cooled reactors feasible. Such reactors and MHD generators make up attractive multi-MW electric power systems for either space or ground applications. A turbo-MHD system using a turbine driven compressor is the most attractive cycle. It has high cycle efficiency and low radiator area and temperature for space applications. A space-power system with 10 MW electric output, shielded for manned missions, could achieve specific masses of 3.5 to 5 kg/kWe. A ground-power station with 60 percent efficiency also appears feasible. (Author)

N70-36137# Committee on Interior and Insular Affairs (U.S. Senate).

MAGNETOHYDRODYNAMICS (MHD): POLLUTION-FREE PRODUCTION OF ELECTRICAL ENERGY FROM LOW-GRADE COAL

Washington GPO 1970 122 p refs Hearing before Comm. on Interior and Insular Affairs, 91st Congr., 1st Sess., 18 Dec. 1969

Avail: Subcomm. on Minerals, Mater., and Fuels

Congressional hearings are reported on development of magnetohydrodynamic (MHD) generators as future sources of power. The use of MHD generators for production of electrical energy is described as almost pollution-free, requiring small quantities of water without thermally polluting the waters used in the process. The process can also utilize low-grade coal as the basic raw material, thus permitting exploitation of coal resources which are not economically feasible in conventional steam generating plants. See also N70-36136.

R.B.

N70-36136# Committee on Interior and Insular Affairs (U.S. Senate).

MAGNETOHYDRODYNAMICS (MHD): POLLUTION-FREE PRODUCTION OF ELECTRICAL ENERGY FROM LOW-GRADE COAL, PART 2

Washington GPO 1970 120 p refs Hearing before Comm. on Interior and Insular Affairs, 91st Congr., 2d Sess., 23 Feb. 1970 Avail: Subcomm. on Minerals, Mater. and Fuels

73V22419 1971 ISS 00 TK2970.146 1971A 0-119204-86-X 621.312139

LC-72-181669

PROCEEDINGS. COMPTE RENDU.

5TH, INTERNATIONAL CONFERENCE ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATION, MUNICH, 1971.

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT; H.M.S.O.; PARIS, LONDON, 501 P. ILLUS. 30 CM.

IN ENGLISH, FRENCH INCLUDES A CONTRIBUTION IN FRENCH. "ORGANIZED JOINTLY BY THE OECD EUROPEAN NUCLEAR AGENCY AND THE INTERNATIONAL ATOMIC ENERGY AGENCY." INCLUDES BIBLIOGRAPHICAL REFERENCES.

LC MAGNETOHYDRODYNAMIC GENERATORS -- CONGRESSES. ADDED ORGANIZATION FOR ECONOMIC COOPERATION AND DEVELOPMENT.

EUROPEAN NUCLEAR ENERGY AGENCY. INTERNATIONAL ATOMIC ENERGY AGENCY. MAIN-MEET TRACE-CORP* CATLG BY-LC

/ / PUPL IN FRANCE

1970

TK2896.155 1970

MHD POWER GENERATION FOR CENTRAL STATION APPLICATION. Kantowitz, A. R.; Ross, R. J. (Avco Everett Research Lab., Everett, MA). pp 18.8-18 of Energy 70.

Proceedings, Vol. 2. Hinsdale, Ill.: American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912- (Vol.2).

The status of combustion-driven MHD generator technology is reviewed from the viewpoint of electric utility applications and its prospects for utilization are discussed. Both base load and emergency or peaking systems are considered. In the case of base load stations, MHD systems reach substantially higher overall thermal efficiencies than those attainable with conventional methods together with greatly reduced pollution of both air and water. For emergency or peaking power, MHD offers a relatively simple power system with the capability of delivering full rated power from a cold start in a few seconds. System design studies, economic estimates and pollution control aspects are presented. The overall benefits offered by these MHD generator systems warrant the further development required for their commercial realization and a program to achieve this goal is outlined. (auth)

(NP-19944) MHD SYSTEM WITH DUAL-PRESSURE MELT GASIFICATION AND CO₂ RECYCLE. Research and Development Report No. 58. (Westinghouse Research Labs., Pittsburgh, Pa. (USA)). 1970. Contract 14-01-0001-1199. 46p. GPO \$0.55.

The thermodynamic and design parameters of a system for generation of electrical power from cool or char by the MHD process, which features utilization of exhaust stream heat for the endothermic heat of reaction in a char gasification process, are described. (TfD)

642

A70-39325 Survey of liquid metal magnetohydrodynamic energy conversion cycles. Frederick H. Morse (Maryland, University, College Park, Md.). *Energy Conversion*, vol. 10, July 1970, p. 155-176. 38 refs.

Description and comparison of the proposed liquid-metal MHD cycles with a summary of the present state of their development. A brief report of the evolution and status of liquid-metal MHD power generation systems is presented. The maximum predicted efficiencies for the four basic liquid-metal MHD cycles and all modifications included in this review are tabulated. The maximum cycle temperature ranged from 1120 to 1500 K, with a mean value of 1370 K. The minimum cycle temperature ranged from 700 to 1080 K, with a mean value of 920 K, and the generator was assumed to have an efficiency of 70%. Z.W.

N71-30468# Kernforschungsanlage, Juelich (West Germany). Inst. fuer Technische Physik.
APPLIED MAGNETOHYDRODYNAMICS. NUMBER 5:
MHD-NUCLEAR POWER STATIONS [ANGEWANDTE
MAGNETOHYDRODYNAMIK. HEFT 5:
MHD-KERNKRAFTWERKE]
 T. Bohn, K. Grawatsch, P. Komarek, and G. Noack. Aug. 1970
 231 p. refs. In GERMAN
 (JUL-689-TP) Avail: AEC Depository Libraries

In an attempt to give a comprehensive representation of the developmental problems facing future magnetohydrodynamic nuclear power plants, an analysis was performed on a number of components. These included: the reactor, MHD generator, transformer, superconducting magnet, heat exchanger, seed material circuit, turbines, and high temperature transmission elements. Following parametric studies of possible design data, specifications could be placed on conventional components, and those requiring special developmental efforts could be identified. It appears that a sufficient technological basis exists for constructing the necessary turbines, heat exchanger, high temperature transmission elements, and electrical transformer. The MHD channel, superconducting magnet, and seed-material circuit need intensive development studies. Technological problems still open are the stability of large seed material deposition. The biggest development problem lies in the area of high temperature reactors, since an increase in the gas outlet temperature to 2000 C assumes great improvements in coated-particle technology. Circuit optimization and cost studies indicate that the costs of the individual components, with the exception of the reactor, are already well known. Author (NSA)

MHD System with Dual Pressure Melt Gasification and CO₂ Recycle
 Issued July, 1970
 R&D Report No. 58—Final Report
 Contractor: Westinghouse Electric Corporation
 Refer to: Titled report and GPO Catalog No. 163.10:58
 Price: \$0.55

Study of MHD Power System Burning Char with Oxygen
 Issued June, 1970
 R&D Report No. 54—Final Report
 Contractor: Avco Everett Research Laboratory
 Refer to: Titled report and GPO Catalog No. 163.10:54
 Price: \$0.35

QC809.M3593 1970

A70-40001 • Jet Propulsion Laboratory, Symposium on Engineering Aspects of Magnetohydrodynamics, 11th, California Institute of Technology, Pasadena, Calif., March 24-26, 1970, Proceedings. Edited by D. G. Elliott. University, Miss., Mississippi. University, 1970. 221 p. \$10.00.

A71-13704 # Electrofluid dynamic energy conversion - Present status and research areas. Maurice Lawson and Hans von Ohain (USAF, Aerospace Research Laboratories, Wright-Patterson AFB, Ohio). American Society of Mechanical Engineers, Paper no. 70-Enr-A, 1970. 20 p. 70 refs. Members, \$1.00; nonmembers, \$2.00.

This paper presents in depth the major basic performance characteristics of electrofluid dynamic (EFD) energy conversion processes, which are shown to be complementary to magnetofluid dynamic processes. With a view toward making possible effective thermal electric energy conversion without moving parts, the potential compatibility of incorporating low pressure ratio EFD processes into high pressure ratio thermodynamic cycles is shown. Investigations of scaling, similarity, performance characteristics, and the effects of physical properties of working media containing electric charges of one polarity are used as a basis to determine the major problems and corresponding research areas in EFD energy conversion. In general these are: generation of charged colloid; electrode and conversion duct geometry; and fluid dynamic energy transfer phenomena in multicomponent, multiphase flows. Also given are typical configurations of EFD energy converters, and a look at potential applications, especially those associated with encapsulated, long-duration power supply for operations in space, under the ocean, or at remote unattended sites. (Author)

A70-30636

EGD energy converter geometry studies. D. M. France and G. J. Trezek (California, University, Berkeley, Calif.). *Energy Conversion*, vol. 10, Apr. 1970, p. 99-104. 6 refs. Research supported by the Chancellor's Patent Fund.

Investigation of system geometries of the electrogas-dynamic (EGD) energy converter to obtain maximum power efficiencies for the conversion process. A comparison of three slender EGD conversion channels, abrupt expansion, free jet, and divergent, is made with respect to the operating characteristics, current ratio, voltage amplification ratio, and electrical power efficiency. The effect of the channel length parameter of the abrupt expansion and free jet channels on the operating characteristics over a range of load resistance up to 10 to the 11th power ohms is then examined. The results as they relate to the electrical power efficiency indicate a correlation between channel length and load resistance for peak efficiency. O.M.

COAL COMBUSTION SYSTEM FOR MHD GENERATORS

Zellinski, J. J.; Teno, J.; Westra, L. F. (Avco Everett Research Lab., Everett, MA). pp 7.41-8 of Energy 70, Proceedings, Vol. 1, Hinsdale, Ill.: American Nuclear Society (1970).

From 5th annual Intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912- (Vol.1).

A system for burning pulverized coal at high pressure with preheated, oxygen-enriched air at high volumetric heat release rates was developed. The experimental program showed that a residence time of 30 milliseconds is sufficient to obtain over 95% combustion efficiency. Volumetric heat release rates of the order of 10^4 Btu/hr/ft³ were obtained. Heat flux in an insulated combustion chamber of 10×10^4 Btu/hr/ft² was measured. A wide variety of coals can be handled by the system, with the indication that low-grade coals can be used without difficulty. (auth)

A70-25525

MHD power generation: Engineering aspects. G. J. Womack (Central Electricity Generating Board, Marchwood Engineering Laboratories, Southampton, Hants., England). London, Chapman and Hall, Ltd.: New York, Barnes and Noble, Inc., 1969. 169 p. 91 refs. \$9.50.

A basic and comprehensive treatment of the engineering aspects of MHD power generation is presented. The ionization and electrical conductivity of the working gas is examined together with the motion of the conducting incompressible fluid in a magnetic field. Special attention is given to the Saha equation and its different forms. The electrodynamic aspects of an MHD generating duct are considered, starting from simplified electrodynamic aspects of MHD generators and description of the Hall effect of electrons and ions. The basic configurations of an MHD generator are then described and a summary is presented of the applications of the four generator configurations.

MHD POWER GENERATION: CURRENT STATUS.

J.F. Dicks, et al.

Mechanical Engineering, v.91, no.8, Aug.1969; p.18-25.

TK2970. British MHD Collaborative Committee.

B7
1969

Open-cycle MHD power generation; results of research carried out by members of the British MHD Collaborative Committee. Edited by J. B. Heywood and G. J. Womack. 1st ed., Oxford, New York, Pergamon Press (1969),

xiii, 385 p. illus. (part fold.) 24 cm.

Includes bibliographies.

N70-37070*# Scientific Translation Service, Santa Barbara, Calif.
DEVELOPMENT OF INSTALLATIONS FOR DIRECT
CONVERSION OF HEAT INTO ELECTRICAL ENERGY BY
MEANS OF MHD GENERATORS AND OTHER NEW ENERGY
DEVICES

In its The Inst of High Temp. of the USSR Acad. of Sci. The
Most Important Results of Sci. Res. in 1969 Aug. 1970
p 45 -83 refs

Avail: CFSTI CSCL 10A

Research connected with the development of stationary electrical power plants is reported and includes the following: (1) Investigations were conducted on metallic electrodes of steel and copper and also on ceramic electrodes of silicon carbide and zirconium dioxide. (2) Experimental equipment was built for studying the dynamics of processes adjacent to electrodes and permitting electro-optical detection of spots with time resolutions down to 10 to the minus 8th power sec with simultaneous measurement of charged particle concentration in the cathode region with time resolutions as low as 5×10 to the minus 8th power sec. (3) Investigation of the high-current discharge on electrodes covered directly with an additive in the MHD generator channel demonstrated that the intensity of the electrode disintegration process by pinched discharge is reduced by a factor of ten. (4) Thermal efficiency studies were made of the combined open cycle MHD power plants with various methods of achieving the high temperatures of the combustion products. (5) Theoretical and experimental studies of problems connected with the development of liquid metal MHD power plants were conducted. D.L.G.

74V36651 1969 ISS 00 TK2970.U55 621.312139 LC-78-603931
MHO FOR CENTRAL STATION POWER GENERATION A PLAN FOR ACTION.
PREPARED FOR THE EXECUTIVE OFFICE OF THE PRESIDENT, OFFICE OF SCIENCE
AND TECHNOLOGY, BY PANEL ON MAGNETIC HYDRODYNAMICS (M-1). LOUIS H.

RODDIS, CHAIRMAN.
UNITED STATES. PANEL ON MAGNETIC HYDRODYNAMICS.
OFFICE OF SCIENCE AND TECHNOLOGY, ENERGY POLICY STAFF, WASHINGTON
2, 35 P. ILLUS. 24 CM.

BIBLIOGRAPHY P. 31-35.
LC MAGNETIC HYDRODYNAMIC GENERATORS.
ADDED RODDIS, LOUIS HARRY, 1918- / UNITED STATES. OFFICE OF SCIENCE
AND TECHNOLOGY. ENERGY POLICY STAFF.
MAIN-CORP TRACE-CORP*TITL*AUTH* CATLG BY-LC

/

73V19414 1969 ISS 00 TK2975.B5 621.312139 LC-72-132893
A/BIBLARZ, OSCAR.
ELECTROHYDRODYNAMICS RESEARCH.
MANAGEMENT INFORMATION SERVICES DETROIT, #172, P. ILLUS. 28 CM.
REPORT OF PROGRAM AT THE NAVAL POSTGRADUATE SCHOOL, MONTEREY,
CALIF., SPONSORED BY NAVAL AIR SYSTEMS COMMAND. INCLUDES 2 MASTER'S
THESES FROM THE NAVAL POSTGRADUATE SCHOOL "ION INJECTORS FOR SINGLE
AND TWO-PHASE ELECTROGASDYNAMIC GENERATORS #BY WILLIAM TAYLOR OBER 11"
(P. #73, -#119,) AND "MOLECULAR-ION ELECTROGASDYNAMIC FLOW CHANNEL #BY
DAVID WILLIAM WALLACE" (P. #121, -#172,). INCLUDES BIBLIOGRAPHIES.
LC ELECTROHYDRODYNAMIC GENERATORS.
ADDED OBER, WILLIAM TAYLOR. ION INJECTORS FOR SINGLE AND TWO-PHASE
ELECTROGASDYNAMIC GENERATORS. 1969. WALLACE, DAVID WILLIAM.
MOLECULAR-ION ELECTROGASDYNAMIC FLOW CHANNEL. 1969. UNITED STATES.
NAVAL POSTGRADUATE SCHOOL, MONTEREY, CALIF.
MAIN-AUTH TRACE-CORP*TITL*AUTH* CATLG BY-LC

N69-18439# Advisory Group for Aerospace Research and Development, Paris (France).

SELECTED TOPICS IN ELECTROFLUID DYNAMIC ENERGY CONVERSION

Maurice O. Lawson ed., and Frank Wattendorf, ed. Dec. 1968
260 p refs Presented at Electrofluid Dyn. Workshop Conf.,
Wright-Patterson AFB, Ohio, 23-25 May 1966 Supported in part
by ARL

(AGARDGRAPH-122) Avail: CFSTI

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1. THE ROLE OF ELECTROFLUID DYNAMICS IN THE FIELD
OF DIRECT ENERGY CONVERSION H. V. Ohain (Aerospace Res.
Labs.) p 5-13

2. ELECTROFLUID DYNAMIC ENERGY CONVERSION
PROCESSES CHARACTERISTICS AND RESEARCH AREAS M. O.
Lawson (Aerospace Res. Labs.) p 14-33 refs

3. EFFECTS ON ELECTRODE GEOMETRY SIMILARITY AND
SCALING LAWS IN EFD ENERGY CONVERSION PROCESSES.

PART 1: FUNDAMENTAL CONSIDERATIONS J. A. Decaire
(Aerospace Res. Labs.) p 34-63 refs

4. EFFECTS OF ELECTRODE GEOMETRY SIMILARITY AND
SCALING LAWS IN EFD ENERGY CONVERSION PROCESSES.

PART 2: EXPERIMENTAL RESULTS J. R. Wifall (Aerospace Res.
Labs.) p 64-95

5. WORKING MEDIA FOR ELECTROFLUID DYNAMIC
GENERATORS M. Hawes (Aerospace Res. Labs.) p 96-123
refs

6. SOME ANALYTICAL TREATMENTS OF EFD PROCESSES
J. E. Minardi (Aerospace Res. Labs.) p 124-179 refs

7. SOME REMARKS ON EFD ENERGY CONVERSION
J.-P. Contzen (Von Kaman Inst. for Fluid Dyn.) p 180-186 refs

8. DESIGN AND CONSTRUCTION OF A 3-MW
MAGNETOGASDYNAMIC POWER GENERATION FACILITY AT THE
UNIVERSITY OF TORONTO INSTITUTE OF AEROSPACE STUDIES S.
J. Townsend (Toronto Univ.) p 188-202

9. PLASMA RESEARCH IN DENMARK K. Refslund
(Tech. Univ.) p 203-204

10. COMMENTS ON ELECTROFLUID DYNAMICS AND
RELATED RESEARCH IN FRANCE J. Fabri (Office Natl. d'Etudes
et de Recherches Aeronautiques) p 207-209

11. THE ELECTROFLUID DYNAMIC ENERGY CONVERTER
WITH SPACECHARGE NEUTRALIZATION E. Knoerschild and P.
A. Schoeck (Deutsche Versuch. fur Luft- und Raumfahrt)
p 210-232

12. COMMENTS ON ELECTROFLUID DYNAMICS AND
RELATED RESEARCHES IN ITALY L. G. Napolitano (Naples
Univ.) p 234-243 refs

13. INTEREST AND PROGRESS IN ELECTROFLUID
DYNAMICS AND RELATED RESEARCHES IN ENGLAND R. G.
Voysey (British Embassy) p 244-262 refs

N70-36408# Air Force Systems Command, Wright-Patterson
AFB, Ohio, Foreign Technology Div.

INTERNATIONAL SYMPOSIUM ON MAGNETOHYDRODYNAMIC ELECTRICAL POWER

N. M. Maslennikov et al 22 Sep. 1969 31 p refs Transl. into
ENGLISH from the Russian

(AD-703158; FTD-MT-24-150-69) Avail: CFSTI CSCL 10/2

Contents: Experimental investigation of electrical conductivity of
a plasma on a model MHG generator; Spectroscopic investigation
of an argon-caesium plasma.

TAB

MHD Char Burning Systems

Issued April, 1969

R&D Report No. 49—Final Report

Contractor: Westinghouse Electric Corporation

Refer to: Titled report and PB-184615

Price: \$6.00 **NTIS**

Electrogasdynamics (EGD) Generator Research

Issued May, 1969

R&D Report No. 48—Final Report

Contractor: Gourdine Systems, Inc.

Price: \$4.50 **OFFICE COAL RES.**

A70-14754 #

CRITIQUE OF MHD POWER GENERATION.

William D. Jackson, James E. Klepeis (Avco Corp., Avco Everett
Research Laboratory, Everett, Mass.), and Michael Patrick (Argonne
National Laboratory, Argonne, Ill.).

*American Society of Mechanical Engineers, Winter Annual Meeting,
Los Angeles, Calif., Nov. 16-20, 1969, Paper 69-WA/Pwr-12. 20 p. 55
refs.*

Members, \$1.00; nonmembers, \$2.00.

Discussion of the recent developments in the field of MHD
generators, the status of MHD power generation, and its prospects
for large-scale utilization. Several variations of the basic MHD scheme
are considered, falling into the category of open-cycle and closed-
cycle systems. Primary emphasis is placed on the application of MHD
systems to commercial power networks as a means for substantially
raising the efficiency of conversion of heat into electricity. O.H.

1968

N73-18090# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ANALYSIS OF THERMAL ECONOMY OF COMBINED POWER INSTALLATIONS EMPLOYING OPEN-CYCLE MHD GENERATORS

L. S. Popyrin, N. N. Pshenichnov, and A. M. Roshchin 27 Oct. 1972 28 p. refs. Transl. into ENGLISH from MHD Symp. (Warsaw), v. 5, 1968 p. 2893-2916
(AD-753031; FTD-HT-23-593-72) Avail: NTIS CSCL 10/2

A mathematical model was used to analyze the thermodynamic efficiency of combined power plants incorporating MHD generators. The mathematical model devised by the authors consists of three parts. The first part is designed to describe processes determining the physical parameters of the working media used. The second part describes processes associated with the conversion and transfer of energy in different elements of the installation, including the MHD generator. The third part is a complex model of an actual power plant (including oxygen enrichment of the oxidant.) When the mathematical model was being designed, actual technical restrictions were taken into account, i.e., the extent to which the parameters could be varied, and some of the technological characteristics of the installation.
Author (GRA)

Separate Evaluations of Electrogasdynamics (EGD)

Power Generation

Issued September, 1968

R&D Report No. 35

Contractors: Dynatech Corporation, Iowa State University, and IIT Research Institute

Refer to: Titled report and PB-183091

Price: \$6.00 NTIS

ELECTRICITY FROM MHD, 1968.

Gilli, P.V. and Tchernilin, Yu.

Atomic Energy Review, v.6, no.4, 1968, p.109-112.

SPECIAL ISSUE ON MHD POWER GENERATION.

IEEE Proceedings, v.56, no.9, Sept.1968.

19 papers on generator theory, plasma properties, electrode and wall phenomena, and experiments.

A69-11394

MHD - WHERE AT AND WHERE TO?

Thomas R. Brogan.

Astronautics and Aeronautics, vol. 6, Nov. 1968, p. 48-53. 33 refs.

Discussion of the present state and future prospects of MHD technology. Possible MHD applications in industry are considered, and the performance and cost of the existing MHD generators are reviewed. MHD is viewed as a space-derived technology promising high profits and economic advantages but requiring large investment on a national scale. MHD principles, background information, and comments on work in the U.S., the USSR, the UK, France, and Japan are given.

A68-34377

A REVIEW OF FLUID MECHANICAL AND RELATED PROBLEMS IN MHD GENERATORS.

E. G. Broadbent (Ministry of Technology, Royal Aircraft Establishment, Farnborough, Hants., England).

IN: PROGRESS IN AERONAUTICAL SCIENCES. VOLUME 9.

Edited by D. Küchemann.

Oxford, Pergamon Press, Ltd., 1968, p. 215-327. 158 refs.

Review of some fundamental aspects of MHD power conversion, together with a survey of recent developments in MHD power generation from the viewpoint of fluid mechanics - i.e., with particular attention to the flowfield in the MHD duct. Preliminary attention is given to linear-type channel geometry, followed by an introduction to the basic Faraday generator and to the mixed-type generator. Gasdynamics, boundary layers, and some stability problems are discussed. Certain thermodynamic cycle considerations are discussed, together with parametric studies for duct optimization. Methods available for determining the current and velocity distribution in a straight duct with segmented electrodes are outlined for both dc and ac output. Engineering problems which arise in an MHD plant are discussed in terms of the provision of the magnet and appropriate heat exchangers.

T.M.

N74-10681# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
MAGNETOHYDRODYNAMIC METHOD OF OBTAINING ELECTRICAL ENERGY (COLLECTED ARTICLES)

V. A. Kirilina and A. E. Sheidina 27 Apr. 1973 345 p. refs. Transl. into ENGLISH from the publ. "Magnitogidrodinamicheskiy Metod Polucheniya Elektroenergii" Moscow, Energiya, 1968 273 p.

(AF Proj. 3144)

(AD-765933; FTD-MT-24-1737-72) Avail: NTIS CSCL 20/9

The report is a Russian translation which discusses various techniques in magnetohydrodynamics for energy conversion.

GRA

647

72V35200 1968 ISS 00 TK9008.A77 NO. 324 621.312139 LC-70-400163
A/PALMGREN, S OREN.
THEORETICAL INVESTIGATION OF AN ELECTROGASDYNAMIC GENERATOR.
AKTIEBOLAGET ATOMENERGI, STOCKHOLM, 35 P. ILLUS. 30 CM.
ATOMENERGI, AKTIEBOLAGET. AE 324 10.00 BIBLIOGRAPHY P. 35.
LC ELECTROHYDRODYNAMIC GENERATORS. GAS DYNAMICS.
MAIN-AUTH TRACE-SERS#TITL* CATLG BY-LC
/ / PUBL IN SWEDEN

TK2970.S9 1968 v.1-6

Electricity from MHD, 1968
Symposium on Magnetohydrodynamic Electrical
Power Generation. Warsaw, 1968.
Electricity from MHD, 1968. Proceedings
of a symposium on magnetohydrodynamic elec-
trical power generation, held by the IAEA,
at Warsaw, 24-30 July 1968. Vienna, IAEA,
1968.
5 v. (Proceedings series)
Contents.--v.1. Closed-cycle MHD with gas-
eous working fluids (Sec.1-a-1-g).--v.2.
Closed-cycle MHD with gaseous working fluids.
(Sec.1-h-1-k).--v.3. Closed-cycle MHD with
liquid-metal working fluids. (Sec.2).
--v.4. Open-cycle MHD. (Sec.3-a - 3-3).
--v.5. Open-cycle MHD. (Sec.3-f - 3-b).

N62-11220# Brookhaven National Lab, Upton, N. Y.
HYBRID FOSSIL-NUCLEAR FUELED MHD POWER CYCLES
W. Stenberg, J. Powell, M. Beller, and B. Manowitz. Jun. 1968
15 p. ref.
(BNL-12569) Avail: CFSTI
A description is given of three alternate combination fossil
nuclear fueled MHD power cycles (combination of a coal gasifier
with a MHD generator) H₂-O₂, CO-O₂, and CO + H₂-air. The
reforming and combustion reactions in each cycle are described,
and their advantages and disadvantages are compared. Energy
balances and efficiencies are given. The original conceptual cycle is
described in BNL-12319-R.
NSA

678

N68-26381# Brookhaven National Lab., Upton, N. Y.
 POLLUTION-FREE HYBRID FOSSIL-NUCLEAR FUELED MHD
 POWER CYCLE

M. Steinberg, J. R. Powell, M. Beller, and B. Manowitz (1968)
 51 p refs Presented at the Conf. on Intern. Energy Conversion
 Eng., Denver Sponsored by AEC

(BNL-12319; CONF-660837-1) CFSTI: HC\$3.00/MF \$0.65

A hybrid power plant is developed based on a hydrogen-oxygen
 combustion MHD cycle. Hydrogen is generated by reforming fossil
 fuel with nuclear generated steam and oxygen is obtained from air
 in an air separation plant. Steam is injected into the combustion
 gases to control temperature and pressure through the duct. A
 preliminary parametric study of the cycle efficiency and MHD
 characteristics is made with steam and helium as diluent. Overall
 thermal efficiencies of 55% appear practical with nuclear energy
 contributing 38% and coal 62% to the power cycle. The hybrid
 system allows the use of fossil fuel in a pollution-free plant;
 conventional water and gas-cooled nuclear reactors can be utilized
 in an MHD cycle; thermal pollution is significantly decreased; a
 clean MHD duct is provided.
 Author (NSA)

A68-42500 MAGNETOHYDRODYNAMIC ENERGY CONVERSION.

R. J. Rosa (Avco Corp., Avco-Everett Research Laboratory,
 Everett, Mass.). **TK2970, R65**
 New York, McGraw-Hill Book Co., 1968. 246 p.
 \$17.50.

This volume reviews the basic principles and practical aspects
 of MHD energy conversion for graduate students and engineers in-
 terested in applied MHD. Detailed explanations and derivations from
 first principles are avoided, although the principal characteristics
 of an MHD generator, the basic concepts, and the magnetic Reynolds
 numbers are treated. Ionization and conductivity are described,
 basic equations and general features of fluid mechanics are described.
 Hall and ion slip effects are investigated with regard to the engineer-
 ing consequences. Design considerations are noted, and practical
 applications such as rocket generators, cavity reactors, radiating
 power plants, and propellant-cooled propulsion systems in the
 aerospace field are discussed. The appendices give transport
 properties in a multicomponent gas; calculated curves of conduc-
 tivity and Hall parameters, magnetic strengths, constants; and a
 method for the calculation of the generator performance. R.M.

FACTORS INFLUENCING ELECTRO-FLUID DYNAMIC POWER GENERATION.

H.E. Brandmaier and T.H. Dimmock.
 J. Spacecraft & Rockets, v.4, no.8, Aug.1967,
 p.961-966.

N66-29718# Los Alamos Scientific Lab., N. Mex.
 NUCLEAR REACTOR MAGNETOHYDRODYNAMIC POWER
 GENERATION

Ralph S. Cooper, Lawrence A. Booth, R. J. Fries, P. G. Salgado,
 L. D. Kirkbride et al 20 Jan. 1966 52 p refs
 (Contract W-7405-ENG-36)

(LA-3368) CFSTI: HC \$3.00/MF \$0.50

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3. THERMODYNAMIC CYCLES AND PLANT STUDIES
 p 14-15
4. POWER PLANT ECONOMICS p 15
5. AN EXPERIMENTAL-SIZE REACTOR-MHD TEST
 p 15-19 refs
6. GRAPHITE REACTOR MATERIALS R. J. Fries p 19-
 22 refs
7. CESIUM-GRAPHITE COMPATIBILITY P. G. Salgado
 p 22-23
8. REFRACTORY-METAL FUEL ELEMENTS FOR REAC-
 TOR APPLICATION TO MHD L. D. Kirkbride p 24-25 ref
9. REACTOR CORE THERMAL ANALYSIS C. A. Rhodes
 p 25-30 refs
10. SCALING LAWS AND THE ENVELOPE OF ALLOW-
 ABLE OPERATING CONDITIONS FOR AN MHD GENER-
 ATOR USING INERT GASES R. J. Rosa (AVCO-Everett Res. Lab.)
 p 30-39 refs
11. MHD CHANNEL CALCULATIONS R. S. Cooper p 39
 ref
12. MHD CYCLE THERMODYNAMICS AND 1000-MW
 PLANT STUDIES L. A. Booth p 40-50 refs
13. TURBOMACHINERY FOR MHD APPLICATION W. E.
 Crowe p 51

TK2970.59 1966 V.1-3

Symposium on Magnetohydrodynamic Electrical Power
 Generation, Salzburg, 1966.
 Electricity from MHD; proceedings. Vienna,
 International Atomic Energy Agency, 1966.

Jointly organized by the International Atomic
 Energy Agency and the European Nuclear Energy
 Agency of the COMECON.

TK2896.I55 1967
32564

**Intersociety Energy Conversion Engineering Conference,
Miami Beach, Fla., 1967.**

Advances in energy conversion engineering; papers, cri-
tiques, and summaries. New York, American Society of Me-
chanical Engineers (1967,

xv, 1124, v, 250 p. illus. 28 cm.

Sponsored by the American Society of Mechanical Engineers.
Includes bibliographies.

**MAGNETOHYDRODYNAMICS AND
ELECTROGASDYNAMICS**

Chairman: Malcolm S. Jones Jr.

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Engineering Developments in Energy Conversion.
(Presented at Internat. Conf. on Energetics, Rochester Univ.,
Aug. 18-20, 1965, Amer. Soc. Mech. Eng.)

MAGNETOHYDRODYNAMICS

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N70-36803* Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**TWO-FLUID MAGNETOHYDRODYNAMIC SYSTEM AND
METHOD FOR THERMAL-ELECTRIC POWER CONVERSION**
Patent
David G. Elliott, inventor (to NASA) Issued 24 Nov. 1964 (Filed
25 Jul. 1962) 8 p. Cl. 310-11 Sponsored by NASA
(NASA-Case-XNP-00644; US-Patent-3,158,764;
US-Patent-App-SN-212496) Avail: US Patent Office CSCI 108
A gas driven jet pump is used to provide high velocity
flow of a liquid metal through a magnetic field to generate
electrical energy. The liquid metal and gas mixture expands through
a nozzle where the liquid metal is immediately separated from the
gas and forced to flow as a thin film between two pole pieces
which establishes current flow through the liquid. R B

N65-24860 Westinghouse Electric Corp., Pittsburgh, Pa.
THE FEASIBILITY OF MHD POWER GENERATION
 W. S. Emmerich. In Okla. State Univ. Proc. of the 2nd Ann.
 Energy Conversion and Storage Conf., Oct. 12-13, 1964
 [1964] 6 p (See N65-24850 14-03) Available from Okla.
 State Univ.: \$5.00

The principle of the magnetohydrodynamic (MHD) generator and average characteristics of such generators are presented. The most noteworthy experimental results was 11 MW generated during 55-sec runs and 10 KWe during 1-hour runs, with open cycle generators. Experiments with closed cycle generators are promising but are not as advanced as those with the open-cycle types. An experimental MHD generator is shown capable of developing 10 KW. The combustion system uses fuel oil and oxygen and was designed on the basis of jet-engine principles. The system operated for about 1 hr at which time the oxygen supply was exhausted. The experiment confirmed the MHD laws used to design the generator and established sufficient evidence for extrapolation of the design to generators of much larger size. E E B.

SATKOWSKI, J. A., ED.

Magnetohydrodynamic electrical power generation, Proceedings of an International symposium, Paris, 6-11 July 1964 (Analyzed in NSA under CONF-640701). Paris, Organisation for Economic Co-operation and Development, 1964.

4 v.

TK2970.E8, V1-4

A68-22534
 POTENTIALITIES OF DIRECT ELECTRO-FLUID DYNAMIC ENERGY CONVERSION PROCESSES FOR POWER GENERATION.
 Hans Von Ohain and Frank Wattendorf.
 IN: COMBUSTION AND PROPULSION: AGARD COLLOQUIUM ON ENERGY SOURCES AND ENERGY CONVERSION, 6TH, CANNES, FRANCE, MARCH 16-20, 1964, PAPERS. [A68-22514 09-03]
 Research sponsored by the Combustion and Propulsion Panel of NATO-AGARD.
 Edited by H. M. DeGroot, R. F. Hoglund, J. Fabri, T. F. Nagay, and R. E. Rumbaugh, Jr.
 New York, Gordon and Breach, Science Publishers, Inc. (AGARDograph 81), 1967, p. 541-561. 11 refs.

Discussion of current research on electrofluid dynamics (EFD) conversion, whereby the fluid dynamic energy of a working medium containing ions or charged colloids is transformed into electrical energy by passing through an electrostatic field. EFD processes are characterized by low current density and high voltage. While the power density is lower than that indicated for magnetofluid dynamics, the power-to-weight ratio may still prove favorable, due to the lack of need for heavy magnetic equipment. A review is given of recent studies of the fundamental relationships between aerothermodynamic and electrical performance characteristics,

TL500.N6 no.81

MAGNETOPLASMA DYNAMIC ELECTRICAL POWER GENERATION.

Report of a symposium held at King's College, Univ. Durham, Newcastle upon Tyne, 6-8 Sept., 1962.
 London, Institution of Electrical Engineers, 1963.

TK2970.I59

N62-12271 Space Sciences Lab., General Electric Co., Philadelphia, Pa.

ELECTROHYDRODYNAMIC POWER GENERATION—EXPERIMENTAL STUDIES.

John M. Smith. Mar. 1962. 20 p. 3 refs.
 (N62SD27) (Contract AF 33(616)-7339)

The series of experiments reported here were performed to establish the feasibility of generating electrical power by means of a generator based upon the principle of the Van de Graff generator, the primary difference being that the charge is transported in a moving gas rather than on a moving belt. The experiments were performed using a corona ionization source and showed that a net electrical output could be obtained, thereby establishing the feasibility of such a generator. (Author Abstract)

TK McGrath, Ian Alexander, ed.

Advances in magnetohydrodynamics; proceedings of a colloquium organized by the Department of Fuel Technology and Chemical Engineering at Sheffield University, October 1961. Edited by I. A. McGrath, R. G. Siddall, and M. W. Thring. New York, Symposium Publications Division, Pergamon Press, 1963.

x, 140 p. illus. 24 cm.

C52

K. GAS AND STEAM TURBINES

1974

N74-16900* # National Aeronautics and Space Administration.
Lewis Research Center, Cleveland, Ohio.

H2-O2 COMBUSTION POWERED STEAM-MHD CENTRAL POWER SYSTEMS

G. R. Seikel, J. M. Smith, and L. D. Nichols 1974 14 p refs
Presented at Hydrogen Economy Miami Energy Conf., Miami

Beach, Fla., 18-20 Mar. 1974; sponsored by Univ. of Miami
(NASA-TM-X-71512; E-7890) Avail: NTIS HC \$3.00 CSCL
108

Estimates are made for both the performance and the power costs of H2-O2 combustion powered steam-MHD central power systems. Hydrogen gas is assumed to be transmitted by pipe from a remote coal gasifier into the city and converted to electricity in a steam MHD plant having an integral gaseous oxygen plant. These steam MHD systems appear to offer an attractive alternative to both in-city clean fueled conventional steam power plants and to remote coal fired power plants with underground electric transmission into the city.

Author

GAS TURBINE OFFERS SHORT CUT TO ENERGY ECONOMY.

W.J.R. STOCKS.

Energy Int., v.11, no.4, Apr.1974, p.21-24.

RATING, CAPABILITIES, AND OPERATION OF COMBUSTION GAS TURBINE DRIVEN GENERATORS.

C. Flick.

IEEE Trans. Power Apparatus & Systems, v.PAS-93, no.3, May/June 1974, p.793-802.

Combustion gas turbine driven generators, now widely used for both utility and industrial power generation, require output characteristics that are properly matched to the prime movers' capabilities at varying ambient temperatures as well as the varying turbine combustion temperatures. This paper reviews the requirements for securing such a match and the methods of determining the operating capabilities of such generators, as proposed for the forthcoming ANSI Standard C50.14.

N74-18695 Oregon State Univ., Corvallis.

OPTIMIZATION OF STAGED RANKINE ENERGY CONVERSION CYCLES FOR HIGH EFFICIENCY Ph.D. Thesis

Larry Dean Simmons 1974 183 p

Avail: Univ. Microfilms Order No. 74-4206

The potential of staged Rankine cycle systems for substantially higher efficiency was studied. It was necessary to optimize the cycles to determine maximum potential efficiency, and the sequential unconstrained minimization technique of nonlinear programming was implemented on the CDC 3300 computer for this purpose. Binary, ternary, and quaternary Rankine cycle configurations were optimized for maximum efficiency under a set of realistic constraints. Liquid metal working fluids were used for the higher temperature stages with water for the low temperature stage fluid. Maximum efficiencies are presented for the best cycle configurations with peak temperatures from 900 F to 3000 F. Sensitivity of the results to certain critical assumptions is also included.

Dissert. Abstr.

FLUIDIZED BED COAL COMBUSTION SYSTEM COUPLED WITH A POTASSIUM VAPOR CYCLE.

A.P. Fraas.

Recent Advances in Air Pollution Control, AIChE Symposium Series, v.70, no.137, 1974, p.238-44.

A fluidized bed coal combustion system operating at 1600° to 1700° F. could be used to boil potassium at 1500° to 1600° F. and thus drive a potassium vapor topping cycle. The vapor leaving the potassium turbine would be condensed at about 1000° F. and the heat would be rejected to a conventional steam cycle with a peak steam temperature of 950° F.

By burning the coal in a fluidized bed of limestone or dolomite, the sulfur content of the stack gases can be reduced by a factor of about 10. The high peak temperature of the potassium vapor topping cycle makes possible a combined cycle efficiency of over 50% as compared to 35 to 40% for conventional steam plants and thus reduces the fuel consumption by about 25% and the waste heat rejection by about 50%.

A review of a set of conceptual design studies and the state of the art indicates that the furnace-potassium boiler, the potassium turbine, and the potassium condenser-steam generator can have quite reasonable proportions and that the overall capital cost of the plant would be about the same as for a conventional coal-fired steam plant. The biggest uncertainties appear to be associated with the problems of regenerating the limestone and combustion gas-side corrosion of the stainless steel tubes in the potassium boiler. The meager data available on these two problem areas indicate that the prospect for adequate solutions are promising.

1974

C54

PRODUCTION OF LOW-B.T.U. GAS FROM COAL IN COMBINATION
WITH ADVANCED POWER CYCLES.

S. Dobner, M.J. Gluckman, and A.M. Squires.
Recent Advances in Air Pollution Control, AICHE
Symposium Series, v.70, no.137, 1974, p.223-229.

Under Grant GI-34286 from the RANN Program ("Research Applied to National Needs") of the National Science Foundation, a team at The City College has begun "studies toward improved techniques for gasifying coal." Our primary objective is to study chemistries and unit operations that could be useful in a Coalplex for simultaneous production of pipeline gas, a light aromatic liquid fuel, and electricity (1). We are also undertaking flow sheet studies to identify commercial opportunities as quickly as possible and to guide our experimental work. This paper is our first report on results of flow sheet studies.

GAS TURBINES AND EMERGENCY DIESEL PLANTS IN WEST
BERLIN'S POWER SUPPLY SYSTEM.

K.D. Schellenberg.

IEEE Trans. Power App. & Syst., v.PAS-93, no.1, 1974
p.325-

The power supply system will be described. Operating problems due to West Berlin's "island" situation and siting problems when adding new generating plants are shown. Design and specifications of various gas turbine plants are given. Distinctive features of two types of turbines will be described.

RATING, CAPABILITIES, AND OPERATION OF COMBUSTION
GAS TURBINE DRIVEN GENERATORS.

C. Flick.

IEEE Trans. Power App. & Syst., v.PAS-93, no.3,
May/June 1974, p.793-

Combustion gas turbine driven generators, now widely used for both utility and industrial power generation, require output characteristics that are properly matched to the prime movers' capabilities at varying ambient temperatures as well as the varying turbine combustion temperatures. This paper reviews the requirements for securing such a match and the methods of determining the operating capabilities of such generators, as proposed for the forthcoming ANSI Standard C50.14.

TITLE: Combined Cycle System Studies

AUTHOR: Gluckman, M.J.

CORPORATE AUTHOR: City College of the City
University of New York, Energy Resources
Project, Dept. of Chemical Engineering

ADDRESS: New York, NY 10031

PUBLICATION DESCRIPTION: Paper CCERI-102
presented at Workshop on Power Cycles, held
by RANN Program of National Science
Foundation, Washington, DC, July 23-24, 1973,
18 p.

PUBLICATION DATE: 1973

SPONSOR: National Science Foundation, RANN Program
ABSTRACT: Our studies of combined gas and steam
cycle power generating equipment at The City
College have been aimed at determining the
most efficient techniques for integrating the
power equipment with the fossil fuel
gasification process. The combination of
low-Btu gas processing with gas turbine and
steam turbine power generating equipment
offers many opportunities for improving
overall fuel utilization efficiency by
intelligent interfacing. The gas turbine
compressor can be used to supply the fuel
gasification reactor with high pressure air
at essentially zero cost. The steam system
represents a sink for excess high pressure
steam generated in the gasification process
by cooling the dirty power gas prior to
sulfur removal. The steam turbines also
represent a source of low and intermediate
pressure steam required by the fuel
processing equipment. (auth)

AVAILABILITY: NTIS, PB-228-876 (\$4.00 paper
copy/\$1.45 microfiche)

TITLE: Advanced Power Cycles for Generating Electricity from Coal

AUTHOR: Squires, A.H.

CORPORATE AUTHOR: City College of The City University of New York, Energy Resources Project, Dept. of Chemical Engineering

ADDRESS: New York, NY 10031

PUBLICATION DESCRIPTION: Paper CCEP-101 presented at Workshop on Power Cycles, held by RANN program of National Science Foundation, Washington, DC. July 23-24, 1973.

28 p.

PUBLICATION DATE: 1973

SPONSOR: National Science Foundation, RANN Program

ABSTRACT: This paper reviews the status of combined cycle plants for electric power generation and considers opportunities and alternatives for the future. The most urgent task is to develop technologies for supplying low-Btu gas to combined cycle systems. Additional important efforts are work on systems for cleaning low-Btu gas at high temperature, work on fluidized-bed combustion of coal with special attention to gas cleaning, and study of systems that can burn coal for peakload power. Less urgent tasks include development of combined cycle systems with improved efficiency for firing with low-Btu gas and development of advanced cycles to work in combination with fluidized-bed combustors. (M9)

N74-14455# Solar, San Diego, Calif.
LOW NOX EMISSION COMBUSTOR FOR AUTOMOBILE
GAS TURBINE ENGINES

David J. White, P. B. Roberts, and W. A. Compton Feb. 1973
104 p

(Contract EPA-68-04-0016)

(PB-222818/7; RDR-1705-5; APTD-1441) Avail: NTIS

HC \$7.25 CSCL 13B

The aim was to develop, through both analytical and experimental studies, the basic design criteria and data necessary to produce a low emission combustor. This information was to be utilized in the production of two combustor designs, one for a typical low-pressure regenerative type of engine and the other for a high-pressure engine with partial recuperation. Several model

combustors were produced employing various concepts to obtain low emissions, and these were evaluated as to their suitability for incorporation into a practical engine system. GRA

POWER GAS AND COMBINED CYCLES: CLEAN POWER FROM FOSSIL
FUELS.. W.D. Metz.
Science, v.179, no.4078, Jan.5,1973, p.54-56.

N74-18414# AResearch Mfg. Co., Phoenix, Ariz.
LOW NOX EMISSION COMBUSTOR DEVELOPMENT FOR
AUTOMOBILE GAS TURBINE ENGINES Final Report,
11 May 1971 - 30 Nov. 1972

D. W. Dawson, K. A. Hanson, and R. C. Holder Feb. 1973
273 p refs

(Contract EPA-68-04-0014)

(PB-225133/8GA; AT-6097-R12; APTD-1374) Avail: NTIS
HC \$15.75 CSCL 21E

Thirty-five combustor configurations were tested to determine emission characteristics. Chemical kinetics of emissions formation are discussed. A design technique that achieved significant NOx reductions in a gas turbine combustor was demonstrated. This technique involved the application of recuperator (or regenerator) bypass air directly into the combustor primary zone. The vaporizer combustor resulted in the most significant improvement by the use of bypass flow. The optimum low emissions engine would use an engine cycle and variable bypass flow that have been matched to provide the best balance between fuel economy and related emissions. Variable recuperator bypass is a simple and convenient alternative to variable combustor geometry. The required control system is simpler and has the potential of lower cost; higher reliability; and better maintainability. GRA

N74-10746# Northern Research and Engineering Corp.,
Cambridge, Mass.

LOW NOX EMISSION COMBUSTOR FOR AUTOMOBILE
GAS TURBINE ENGINES

E. P. Demetri and R. J. Mured Feb. 1973 182 p refs

(Contract EPA-68-04-0017)

(PB-222340/2; APTD-1454) Avail: NTIS HC \$11.25 CSCL
13B

Two research combustors were designed and tested, one of which was representative of low pressure-ratio, regenerative gas turbine cycles and the other representative of high pressure-ratio, nonregenerative cycles. The design goal was to achieve emission levels not exceeding one-half of the Federal 1957/76 emission standards. The overall aim was to develop design guidelines on the basis of detailed experimental data. Extensive modifications were made to conventional combustor configurations, but direct use was made of existing combustor design technology. Full-scale models were tested over wide ranges of operating conditions representative of typical driving cycles. Cold-flow tests were made to measure aerodynamic performance and detailed combustion tests were made to measure emission, combustion, and thermal performance. GRA

N74-10745# United Aircraft of Canada, Ltd., Longueuil (Quebec).
LOW NO_x EMISSION COMBUSTOR FOR AUTOMOBILE
 Final Report
 H. C. Eatock, J. A. Saintsbury, P. Sampath, J. R. Keilbach, and L. J. Spadaccini Feb. 1973 259 p refs
 (Contract EPA-68-04-0015)
 (PB-222075/4; APTD-1457; ER-700) Avail: NTIS HC \$6.75
 CSCL 21E

The emission levels that could be reached by development on two combustors representing a 12:1 pressure ratio simple cycle gas turbine, and a 5:1 pressure ratio regenerative cycle gas turbine, both for automotive application were evaluated. Goals were to equal or better the EPA 1975-76 Federal Emission Standards for automobiles. Some 60 atmospheric rig tests were carried out on the simple-cycle combustor whilst 39 atmospheric rig tests were carried out on the regenerative cycle combustor. Some 430 pressure test points involving over 200 modifications to combustor geometry were run. Various fuel injection methods were employed, such as pressure atomizing, air-assisted pressure atomizing, and air-blast atomizing. For reasons of reliability and primary zone leanness, the air-blast atomizer was the final selection. The best results were obtained by the introduction of sufficient air to provide a lean head end (in the form of 3 stages of swirl) while maintaining fairly high temperatures in the intermediate zone, the remainder of the air being introduced into the dilution zone. Effects of outside parameters on combustor emissions were also evaluated. GRA

Low Emission Combustor/Vapor Generator for Automobile Rankine Cycle Engines.
 T. E. Duffy, J. R. Shekelton, R. B. Addoms, and W. A. Compton.

Solar, San Diego, Calif. Oct 73. 330p EPA-460/3-73-004
 PB-230 896/3WP PCS19.50/MFS1.45

This is the final report on a program to demonstrate a low emission vapor generator for automotive Rankine cycle power plants. Program goals were to design and test a low emission system that required low parasitic power, had compact packaging, high steam generator efficiency and suitable controls for fuel, air and water for the regulation of steam pressure and temperature. A steam generator with an output of 1200 pounds per hour at 1000F and 1000 psia was demonstrated by tests to have weighed emissions below the 1976 emission standards over a simulated driving cycle.

STEAM GENERATOR DESIGNS. Clayton, W. H.; Singer, J. G. (Combustion Engineering, Inc., Windsor, CT). Chem. Eng. Progr.; 69: No. 7, 81-82(Jul 1973).

A combined cycle is any one of combinations of gas turbines, steam generators or heat recovery equipment, and steam turbines assembled for the reduction in plant cost or improvement of cycle efficiency in the utility power generation process. The variety of combined cycles discussed for the possibilities for industrial applications include gas turbine plus unfired steam generator; gas turbine plus supplementary fired steam generator; gas turbine plus furnace-fired steam generator; and supercharged furnace-fired steam generator plus gas turbine. These units are large enough to meet the demands for the utility applications and with the advent of economical coal gasification processes to provide clean fuel, the combined-cycle applications are solicited. (MCW)

POWER PLANT GAS TURBINE AND ITS DEVELOPMENT PROSPECTS FROM RUSSIAN ASPECT. Kirillov, I. I.; Arsenov, L. V. Arch. Energielwrt.; 27: No. 11, 814-531(1973). (In German).

A review is given on the most important problems and various possibilities of application of the gas turbine. (OE)

DESIGNING GAS TURBINE HEAT RECOVERY BOILERS. van den Hoogen, L. B. (Nederlandse Electrotechnische Maatschappij, Leiden). Gas Turbine Int.; 14: No. 6, 32-35(1973).

The low thermal efficiency of the simple cycle gas turbines as compared with conventional steam installations have delayed the extension of the application of these engines. With about 70% of the energy leaving the system through the exhaust gases, methods are needed for recovery of the waste heat that is at a temperature of 400 to 500°C. The oxygen concentration is such that additional firing is possible. Based on these conditions a full range of heat recovery boilers and accessories were developed.

1973

Design of Reciprocating Single Cylinder Expanders for Steam.
S. E. Eckard, and R. D. Brooks,
General Electric Co., Cincinnati, Ohio, Nuclear Systems
Programs, Oct 73, 237p EPA-460/3-73-003
PB-231 004/3WE. PCS15.00/MF\$1.45

A reciprocating expander is one type of expander which may be applicable to an automotive Rankine cycle engine. Single cylinder reciprocating expanders were designed and fabricated for the purpose of evaluating solid lubricants and other supporting materials. For high engine efficiency, steam pressure and temperature up to 1000 psia and 1000 F, respectively are necessary. Several lubricants and wear resistant materials were tested in both a crosshead piston and trunk piston configuration. Also a specially compounded water resistant synthetic hydrocarbon oil was evaluated as a crankcase bearing lubricant. Both the crosshead piston and trunk piston expanders were fabricated and tested over a range of conditions depicted as follows: (1) speed range, 500-2000 RPM; (2) inlet steam temperature, 700-1000F; (3) inlet steam pressure, 400-1000 psia; and (4) condenser pressure approximately 20 psia. (Modified author abstract)

N74-18406# National Academy of Sciences - National Research Council, Washington, D.C. Committee on Motor Vehicle Emissions.

NAS REPORT ON TECHNOLOGICAL FEASIBILITY OF 1975-1976 MOTOR VEHICLE EMISSION STANDARDS. AN EVALUATION OF ALTERNATIVE POWER SOURCES FOR LOW-EMISSION AUTOMOBILES, NATIONAL ACADEMY OF SCIENCES

Apr. 1973 161 p refs

(Contract EPA-68-01-0402)
(PB-224859/9GA) Avail: NTIS HC \$4.75; HC also available from NTIS \$26.00/set of 8 reports as PB-224866-SET CSCL 21E

The panel has evaluated several near and long term alternative power systems including diesel, gas turbine Rankine cycle and Stirling engines. In addition electric vehicles and alternative fuels were studied. Various aspects of each engine-system was considered including emissions, fuel economy, noise, cost size and weight, producibility and driveability. The report also discusses the lead time necessary to begin limited and mass production of each system. GRA

1973

658

1973

TITLE: Second Iteration Analysis of A Fossil Fuel-Fired Gas Turbine-Potassium-Steam Combined Cycle

AUTHOR: Lackey, R.E.

CORPORATE AUTHOR: Oak Ridge National Laboratory,

ORNL-RSP Environmental Program
ADDRESS: P.O. Box 1, Oak Ridge, TN 37830

PUBLICATION DESCRIPTION: ORNL-RSP-EP-39, 30 p.

PUBLICATION DATE: 1973, July

SPONSOR: National Science Foundation, RAMP Program

ABSTRACT: The operating conditions and heat balance of the fossil fuel-fired potassium vapor topping cycle as proposed in the initial ORNL study carried out under the MSP-RAMP program have been reexamined in considerable detail. It appears desirable to reduce the peak temperature in the steam system as well as make a number of modifications in the feed heating system. Gas turbine operating experience has been reviewed to provide a firm basis for choosing the turbine inlet temperature and component efficiency for the gas turbine cycle. On the basis of these analyses the operating conditions of the initial study were modified and a new flow sheet and heat balance were prepared using the supercritical pressure steam cycle of the TVA Ball Run steam plant as the point of departure. This gave an overall combined cycle efficiency of 52% and a net heat rate of 6580 Btu/kwhr. (Auth)

(CONF-731105-4) SAFETY AND ENVIRONMENTAL PROBLEMS POSED BY OPERATION OF A POTASSIUM VAPOR TOPPING CYCLE. Fraas, A. P. (Oak Ridge National Lab., Tenn. (USA)). 1973. 18p. Dep. NTIS \$3.00.

From winter meeting of American Society of Mechanical Engineers; Detroit, Michigan, USA (11 Nov 1973).

A review of the special operational, maintenance, and environmental problems posed by a fossil fuel-fired potassium vapor cycle plant indicates that such a system, if well designed, would present unusual and difficult but manageable problems. Leaks should be inherently slow to develop, and relatively simple, reliable instrumentation techniques of adequate sensitivity are available to detect them. The attendant operational and maintenance problems appear to be reasonably tractable. Under routine operating conditions, the gaseous and thermal emissions to the environment should be very low. The worst accident from the standpoint of the public would be the release of a substantial fraction of the potassium inventory to the atmosphere. It appears that such an accident would release about the same amount of alkali metal as the oxide as goes out the stack each day as a sulfate from a conventional coal-fired plant fitted with good fly ash precipitators. (auth)

1973

1973

N74-18412# Aerospace Corp., El Segundo, Calif. Urban Programs Div.
GAS TURBINE ENGINE PRODUCTION IMPLEMENTATION STUDY. VOLUME 1: EXECUTIVE SUMMARY Final Report.
 Jan. - Jul. 1973

D. E. Lapedes, L. Forrest, F. G. Ghahremani, M. Hinton, T. Iura, O. Hamberg, W. U. Roessler, W. M. Smalley, and J. Meltzer
 Jul. 1973 11 p

(Contract EPA-68-01-0417)
 (PB-225465/AGA; ATR-73(7323)-1-Vol-1;
 DOT-TSC-OST-73-26-Vol-1) Avail: NTIS HC \$3.00 HC also
 available from NTIS \$8.00/set of 2 reports as PB-225464-SET
 CSCL 21E

An assessment is given of available information pertaining to implementing mass production of gas turbine powered automobiles. The status of the technology and implementation schedule visibility reported herein is that existing at the time of data acquisition visits made to selected firms and agencies during the period February 28 through April 30, 1973. The results of this study are presented in two volumes. Volume 2 presents a review of important findings and conclusions in the highlights and summary sections. GRA

N74-18413# Aerospace Corp., El Segundo, Calif. Urban Programs Div.
GAS TURBINE ENGINE PRODUCTION IMPLEMENTATION STUDY. VOLUME 2: TECHNICAL DISCUSSION Final Report. Jan. - Jul. 1973

D. E. Lapedes, L. Forrest, F. G. Ghahremani, O. Hamberg, W. U. Roessler, W. M. Smalley, M. Hinton, T. Iura, and J. Meltzer
 Sep. 1973 260 p refs
 (Contract EPA-68-01-0417)
 (PB-225466/2GA; TTR-73(7323)-1-Vol-2;
 DOT-TSC-OST-73-26-Vol-2) Avail: NTIS HC \$6.25 HC also
 available from NTIS \$8.00/set of 2 reports as PB-225464-SET
 CSCL 21E

An assessment is presented of available information pertaining to implementing mass production of gas turbine powered automobiles. The results of this study are presented in two volumes. Volume 2, the Technical Discussion, provides a comprehensive discussion of each study topic and is of interest primarily to the technical specialist. GRA

DYNAMIC MODELS FOR STEAM AND HYDRO TURBINES IN POWER-SYSTEM STUDIES; IEEE COMMITTEE REPORT. IEEE (Inst. Elec. Electron. Eng.), Trans. Power App. Syst.; PAS-92; No. 6, 1904-1915(1973).

Basic models for speed-governing systems and turbines in power system stability studies are presented. These models provide adequate representation for hydro, fossil-fired, and pressurized-water reactor nuclear units in most stability analyses. Models for boiling water reactor nuclear units are to be presented at a later date. Typical parameters are given. (auth)

1973

GAS TURBINE POWER GENERATION: RELIABILITY AND MAINTAINABILITY IN ELECTRIC UTILITY SERVICE. Roberts, W. S. (W. S. Roberts Engineering Co., Indianapolis). Gas Turbine Int.; 14: No. 4, 18-25; 33; 47(1973).

Gas turbine reliability and maintenance were discussed by personnel from Public Service Electric and Gas Company, Newark, New Jersey; Philadelphia Electric Company, Philadelphia, Pennsylvania; and Long Island Lighting Company, Hicksville, New York. Many areas of discussion were presented including such things as avoiding engine-generator mismatch; fuel quality; start-up factors; control systems; lubricating systems; overhaul facilities; inspections; instrumentation; and all accessories. Total energy systems must be considered since exhaust stacks are getting higher, environmental standards changing, and engineering problems encountered due to multiple unit construction. (MCW)

A73-34376

Conference on Heat and Fluid Flow in Steam and Gas Turbine Plant, University of Warwick, Coventry, England, April 3-5, 1973. Proceedings. Conference sponsored by the Institution of Mechanical Engineers. London, Institution of Mechanical Engineers (IME Conference Publication, No. 3), 1973. 291 p.

Experimental and theoretical research on heat transfer and flow characteristics in steam and gas turbine machinery is described in papers dealing with instrumentation, testing procedures, data evaluation, and theoretical models. Topics considered include flow of steam-water mixtures through sharp-edged orifices, reentrainment of deposited liquid from steam turbine fixed blades, effects of bulk heat transfers in aircraft gas turbines on compressor surge margins, prediction of fog-drop size in wet steam turbines, studies of incidence loss models for radial and mixed-flow turbomachinery, rotating stall effects, flow turbulence measurements, and effects of axial velocity variation on subsonic flow through compressor cascades.

ROLE OF GAS AND STEAM TURBINES TO REDUCE INDUSTRIAL PLANT ENERGY COSTS. Wilson, W. B.; Hefner, W. J. (General Electric Co., Louisville, KY). Combustion, 45: No. 5, 32-41(Nov 1973).

Data are given to help industry select the economic fuel and economic mix of steam and gas turbines for energy-conservation measures and costs. Utilities and industrial plants can no longer rely on a firm supply of natural gas to fuel their boilers and turbines. The effect various liquid fuels have on gas turbine maintenance and availability is summarized. Process heat requirements per unit of power, process steam pressure, and the type of fuel will be factors in evaluating the proper mix of steam and gas turbines. The plant requirements for heat, and the availability of a reliable source of electric power will influence the amount of power (hp and kW) that can be economically generated by the industrial. (auth)

659

TK	Intersociety Energy Conversion Engineering Conference, 8th Philadelphia, Pa., 1973.	
2994	Proceedings. New York, American Institute of Aeronautics and Astronautics [1973]	
.155	847 p. illus. 29 cm.	
1973	Held at: University of Pennsylvania, Philadelphia, Pa., August 13-16, 1973.	
	Sponsored by: American Institute of Aeronautics and Astronautics [and others]	

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TK	Intersociety Energy Conversion Engineering	
2896	Conference, 7th, San Diego, Calif., 1972.	
155	Proceedings. Washington, D. C., American	
1972	Chemical Society, 1972.	
	1533 p. illus. 28 cm.	
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1972
Intersociety Energy Conversion Engineering
Conference, 7th, San Diego, Calif., 1972.
Proceedings. Washington, D. C., American
Chemical Society, 1972.
1533 p. illus. 28 cm.

Emission Measurement Techniques for Non-Conventional Powerplants
M. W. Korth, H. A. Ashby, R. C. Stahman. 971

New Prime Movers for Ground Transportation—Low Pollution, Low Fuel Consumption :
E. J. Ward, J. O. Spriggs, F. M. Varney 1013

Combined Nuclear Gas Turbine Power and Desalination Plant, P. H. Sager, J. M. Krase
P. 1299

N73-27551# Environmental Protection Agency, Ann Arbor Mich.
Test and Evaluation Branch.
EXHAUST EMISSION ANALYSIS OF THE WILLIAMS
RESEARCH GAS-TURBINE AMC HORNET
Leonard D. Verrelli and Casimer J. Andary May 1972 15 p
(PB-218687/2; APTD-1410; Rept-72-27) Avail: NTIS HC
\$3.00 CSCL 138

An evaluation was made of field experience with a turbine
powered passenger car. The William Gas Turbine W-26,
regenerative turbine automotive engine was mounted in a 1971
Hornet test vehicle. The engine uses a single power turbine to
develop 80 horsepower. The engine regenerator incorporates two
large discs of a ceramic-glass material for inlet air preheating.
Testing was accomplished using the 1970, 1972, and 1975
Federal Test Procedures. In addition, steady state and pro-
portional sampler tests were conducted. By positioning of the
power turbine bypass in the closed position, it was demonstrated
that low hydrocarbon emissions are possible with this engine;
however carbon monoxide and nitric oxides were not reduced
sufficiently to be able to meet 1975 or 1976 emission stand-
ards. GRA

N74-10747# Chandler Evans, Inc., West Hartford, Conn.
VAPOR GENERATOR FEED PUMP FOR RANKINE CYCLE
AUTOMOTIVE PROPULSION SYSTEM (CHANDLER
EVANS)
R. M. Riordan Dec. 1972 213 p
(Contract EPA-68-01-0430)
(PB-222849/2; R-679-5; APTD-1357) Avail: NTIS HC \$5.50
CSCL 21G

A project was undertaken to conduct comprehensive design
studies pursuant to the selection of conceptual models of vapor
generator feed pumps that will satisfy the performance requirement
of each of three Rankine cycle automotive power systems currently
under development to reduce air pollution. In pursuing the objective
of providing variable output pumps for these applications,
investigations were conducted of two selected courses: (1) fixed
displacement pumps with variable speed drives, and (2) variable
displacement pumps. The report presents a detailed summary of
the project, describes the technical results, and gives conclu-
sions. Author (GRA)

Computer techniques for evaluating gas turbine heat recovery
applications; J.C. STEWART (Henry Vogt Machine Co., Louisville,
Ky); ASME Pap 72-GT-103 for meeting Mar 26-30 1972, 8 p De-
scribes programs which provide an installed cost estimate that can
be used to evaluate the effect of variations in boiler pinch point,
back pressure, stack temperature, superheated steam tempera-
ture, feedwater approach temperature, and supplementary firing
for any gas turbine heat recovery application. Another program
provides operating performance of the selected boiler design
through a range of exhaust conditions due to ambient or load
changes, and also for changes in the steam capacity or pressure
requirements. 5 refs.

N73-28739# Thermo Electron Engineering Corp., Waltham, Mass.
Research and Development Center.
DETAILED DESIGN: RANKINE CYCLE POWER SYSTEM
WITH ORGANIC-BASED WORKING FLUID AND RECIP-
ROCATING EXPANDER FOR AUTOMOBILE PROPULSION.
VOLUME 1: TECHNICAL REPORT
5 May 1972 271 p

(Contract EPA-EHSH-70-102)
(PB-210836; TE-4134-71-72-Vol-1; APTD-1154) Avail: NTIS
HC \$3.00 CSCL 21G

The detailed, optimized design of the system including
packaging of the complete system in the reference car, the 1972
Ford Galaxie is described. The results of experimental development
in several critical areas are also presented. The system is designed
to provide performance approximately equivalent to use of a
351 cubic inch displacement internal combustion engine in the
reference car. Author (GRA)

N74-15138# Lear Motors Corp., Reno, Nev.
VAPOR GENERATOR FEED PUMP FOR RANKINE CYCLE
AUTOMOTIVE PROPULSION SYSTEM Final Report
Max K. Winkler Dec. 1972 72 p refs
(Contract EPA-68-01-0437)
(PB-222871/6; APTD-1358) Avail: NTIS HC \$3.50 CSCL
13K

Results are presented on preliminary design studies conducted
to define feed pumps that satisfy the performance requirements
for the following Rankine cycle automotive power systems: (1)
steam engine systems; (2) aerogel liquid rocket company; and
(3) thermo electron corporation. The approach consisted of
establishing feed pump requirements for the three applications.
Investigations revealed that the feed pump developed by Lear
Motors Corporation satisfies the basic requirements of the three
system contractors. A description of the Lear feed pump and its
operating principle is presented. A summary of the flow
requirements and estimated brake horsepower for the 3 system
contractor feed pumps is shown graphically. GRA

1972

N73-27933# AirResearch Mfg. Co., Phoenix, Ariz.
MERDC (MOBILITY EQUIPMENT RESEARCH AND DEVELOPMENT CENTER) 30 AND 60 KW GENERATOR SET STUDY Final Technical Report, May - Oct. 1972
 Gerald J. Amarel and Roger J. Deffuder Oct. 1972 419 p
 refs
 (Contract DAAK02-72-C-0317; DA Proj. 186-63702-DG-11)
 (AD-762200; GT-8838-R) Avail: NTIS CSCL 10/2

The purpose of the program was to identify the critical characteristics of a gas turbine powered generator set of 30- and 60-kw electrical outputs. The primary conclusions of the program are: The generator set size requirement of 1.7 lb/kw-hr for the 30 kw unit and 1.2 lb/kw-hr for the 60 kw unit can be achieved without having a complicated engine cycle. The recommended engines for both the 30- and 60-kw units have a single-stage centrifugal compressor, a single-can burner and a single-stage radial-inflow turbine mounted on two bearings and featuring an overhung design. The gearbox has a planetary gear drive. The single-frequency generator configuration is recommended over the multifrequency generator configuration based primarily on cost, weight and performance considerations. Author (GRA)

TITLE: Cost Separation of Steam and Electricity for a Dual-Purpose Power Station

AUTHOR: Leung, P.

CORPORATE AUTHOR: Bechtel Corp., Electrical and Industrial Division

ADDRESS: Los Angeles, CA

PUBLICATION DESCRIPTION: Paper presented at American Power Conference, Chicago, IL, April 18-20, 1972. Included in Vol. 3a, 390-408

PUBLICATION DATE: 1972

ABSTRACT: Electric utility companies are planning several dual-purpose plants to be located in the proximity of industrial customers. These plants could generate and supply electricity, and the steam exhausted from the turbines in electric power generation and normally discharged to the environment as waste heat, could be supplied as process steam. This paper discusses several methods of solving the problems involved in separating the costs of process steam and electricity in a dual-purpose station. (DCH)

AVAILABILITY: Conference Director, American Power Conference, Illinois Institute of Technology, Technology Center, Chicago, IL 60616 (\$20.00)

Steam generators for nuclear power plants. P. V. Gilli, R. Fritz. J11 appltech. Conference on Recent Developments in Compact High Duty Heat Exchangers, London, England, 12 Oct. 1972 (London, England: Instn. Mech. Engrs. 1973). P 13-22

Steam generators for nuclear power plants are typical examples of modern high duty heat exchangers with stringent requirements on performance and reliability. Extreme compactness of the heat transfer surface is mandatory because of high unit performance and high operating pressures on both the heat transferring and the steam/water side. Availability of a nuclear power plant depends to a considerable extent on the steam generators, tube failures being a typical reason for steam generator down time. The design and assessment of steam generators for existing and future reactor types is discussed. (12 refs.)

1972

TITLE: The Direct-Cycle Nuclear Gas Turbine with Economical Dry Air Cooling

AUTHOR: Reese, J.H.; Morse, D.C.; Schoene, T.S.

CORPORATE AUTHOR: Gulf General Atomic Co.

ADDRESS: San Diego, CA

PUBLICATION DESCRIPTION: Paper presented at American Power Conference, Chicago, IL, April 18-20, 1972. Included in Vol. 3a, 512-520

PUBLICATION DATE: 1972

ABSTRACT: The application of dry air cooling has not been used in solving the problem of disposal of waste heat generated by large electric power stations because of the large expense involved. However, dry air cooling can be highly desirable in certain situations: wider selection of possible plant sites; no requirement for makeup water; and the elimination of secondary problems such as fogging, snowing, and icing associated with evaporative systems. Therefore, the nuclear gas turbine will become increasingly more important to the electric power production industry as plant siting problems multiply. Using existing proved gas-cooled reactor technology, the nuclear gas turbine can be developed before the necessary natural water resources and most desirable plant sites are gone. By utilizing the nuclear gas turbine, power plants using dry air cooling can not only provide power at a cost comparable or less than present plants using wet cooling; they also can provide power which will be nearly environmentally neutral. (DCH)

AVAILABILITY: Conference Director, American Power Conference, Illinois Institute of Technology, Technology Center, Chicago, IL 60616 (\$20.00)

Richard, C.C.

Northeast Utilities Service Co.

Vary combined-cycle design to fit needs.

Power Engineering, Chicago, 76(7): 40-41, July 1972.

Sum., illus., refs., from Text.

ELECTRIC POWER PLANTS: GAS ENGINES; STEAM ENGINES; HEAT RECOVERY; WATER CONSERVATION; WASTE REUSE; combined-cycle plant; turbines.

The electric utility industry launched an effort to utilize the waste heat from gas turbines by coupling a steam plant with a gas turbine installation. This combined cycle concept recovers a certain percentage of the gas turbine's exhaust heat by passing the high temperature exhaust gases through a heat recovery boiler to produce steam to drive a steam turbine. Increased power and higher efficiency are achieved. The combined cycle power plant could become a competitive alternative to conventional base load units as well as other types of fossil-fired cycling units in the intermediate load range, with the added advantages of reduced emissions of heat to the environment and reduced requirements for cooling water.

1972

N73-10055# Army Foreign Science and Technology Center, Charlottesville, Va.

APPLICATIONS OF AIRCRAFT GAS TURBINE ENGINES IN INDUSTRIAL POWER PLANTS

V. Kh. Vyants 3 Apr. 1972 11 p Transl. into ENGLISH from the book "Gazovye Turbiny" Moscow, 1971 p 42-48 (AD-745832; FSTC-HT-23-1423-72) Avail: NTIS CSCL 10/2

Recently, a new branch of technology, based on the use of aircraft gas turbine engines in electric and transport power plants has been developed, using both new engines and those which have been run out for aviation purposes. The mass production of aviation engines is well tuned up in economically developed countries and their great reserve, especially at the low rate with which they are operated in industrial plants, conditions the technical and economic expedience of their use in this fashion. The basic advantages of installations with aircraft engines by comparison with specially created installations are given.

Author (GRA)

ELECTRIC POWER - VIA MARRIAGE OF CHEMICAL AND AERO-SPACE INDUSTRIES.

F.L. Robson.

Chemtech, Apr. 1972, p.239-249.

The approach that shows the most potential benefits involves essentially pollution free, low-heating value gaseous fuels for use in advanced-cycle power systems that operate at new levels of efficiency. Binary cycles, gas turbine systems, combined-cycle systems, and the COGAS systems are discussed.

N72-30977# Committee on Interior and Insular Affairs (U. S. Senate).

ADVANCED POWER CYCLES

Washington GPO 1972 279 p refs Hearing pursuant to S. Res. 45 before Comm. on Interior and Insular Affairs, 92d Congr., 2d Sess., 8 Feb. 1972

Avail: Comm. on Interior and Insular Affairs

The hearings are reported concerned with new technologies for the environmentally acceptable generation of electricity from coal. The processes for the gasification of coal, and the problem in the removal of sulfur compounds are discussed. Summaries of the EPA activities in compliance with the Clean Air Act are included.

F.O.S.

1971

TITLE: Advanced Nonthermally Polluting Gas Turbines in Utility Application
AUTHOR: Mancardi, P.R.; Peters, G.F.; Landerman, A.M.
CORPORATE AUTHOR: United Aircraft Research Laboratories

ADDRESS: East Hartford, CT 04108
PUBLICATION DESCRIPTION: Water Pollution Control Research Series 16130 DWS 03/71; 26a p.

PUBLICATION DATE: 1971, March
SPONSOR: U.S. Environmental Protection Agency, Water Quality Office

ABSTRACT: Detailed performance, size, and cost estimates were made for advanced simple-, regenerative-, and compound-cycle gas turbine engines for turbine inlet temperatures of 2000 degrees F and above as anticipated to be commercially available in the next two decades. Conceptual designs for 1000-Mw central power station utilizing gas turbines and comparisons of complete gas turbine and steam turbine power station installed costs and total busbar power costs were made for the various regions of the US. It is shown that the gas turbines in the 1970 decade could produce electric power at lower costs than steam turbines in the South Central region of the US where natural gas is readily available. Elsewhere in the US the gas turbines would be economically competitive if moderately priced clean fuels are available. Advanced gas turbines will become more competitive in the 1980 decade as anticipated increases in turbine inlet temperature, component efficiencies and larger engine designs lead to more efficient and lower-cost engines and power stations. Although the development costs for large, advanced gas turbines would approach from 100 to 200 million dollars, the total amount that utilities are expected to expend for cooling devices to combat thermal pollution over the next two decades will exceed more than ten times this amount. Thus advanced gas turbines should be given serious consideration for increased research and development support. (8PA)

1971

Gas turbine heat recovery boiler thermodynamics economics and evaluation; R.W. FOSTER-PEGG; Combustion v 42 n 9 Mar 1971 p 8-18; Conventional and heat recovery boilers are compared with respect to differences in operating conditions and their effect on design. Steam costs from conventional and heat recovery boilers are compared with examples given for specific cases. Optimization of heat recovery boilers for draft loss and approach temperature are illustrated with examples. Finally the advantages and economic penalties of various optional items associated with heat recovery boilers are discussed. 8 refs.

N71-38769# Massachusetts Inst. of Tech., Cambridge. Fluid Mechanics Lab.

THE AUTOMOTIVE GAS TURBINE AND NITRIC OXIDE EMISSIONS

Thomas Mikus and John B. Heywood Jun. 1971 30 p refs (Grant NSF GK-15409)

(FML-Publ-71-11) Avail: NTIS

A model for the formation of nitric oxide, NO, in regenerative automotive gas turbine engines is presented. The model is shown to closely predict relative NO emission trends for an existing engine, while predicting absolute levels within a factor of 2. A typical near future automotive turbine cycle is then described. Engine performance and NO emissions are calculated for this cycle. The trade-off between fuel consumption and NO emissions for conventional combustor design is presented as a function of turbine inlet temperature. The methods by which NO emissions can be reduced are examined, and it is found that to meet the proposed 1976 Federal Emissions Standard for NO(x), the combustor's primary zone must be made considerably leaner and more homogeneous than is typical of current combustor designs.

Author

N71-38450# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

COMBINED TURBINE-MAGNETOHYDRODYNAMIC BRAYTON CYCLE POWER SYSTEM FOR SPACE AND GROUND USE

Lester D. Nichols Washington Oct. 1971 48 p refs

(NASA-TN-D-6513; E-6442) Avail: NTIS CSCL 10A

A combined turbine-MHD generator operating in a Brayton cycle with a NERVA nuclear reactor is considered. Both for use in space and on the ground. The combined system is compared with an all-MHD Brayton system and an all-turbine system. The combined cycle systems have higher thermodynamic efficiencies than the other systems. The combined system with 1500 K turbine inlet and the all-MHD system with generator efficiency of 0.8 have the lowest specific recuperator plus radiator mass of those systems considered. But the combined system considered has an average radiator temperature of 200 to 260 K lower than the other. For ground use, a cycle efficiency of greater than 0.55 can be achieved.

Author

State of the art of small gas turbine engines for helicopters and surface transport; H.H. LANGSHUR (United Aircraft of Canada Ltd, Longueuil, Que), B.J. PALFREMAN; AGARD Lecture Ser n 46 Propulsion and Energetics Panel and Consultant Exchange Program, May 1971 paper 2, 16 p. The paper reviews the current technical and market status of below 1000 shp turboshaft engines, as applied to helicopters and surface transport. Major data are given for the successful engines and comparisons of salient design features are made. Engines now in development are discussed. Advances to be expected in a 1980 helicopter engine are described and the expectations are critically reviewed, 14 refs.

REHEAT STEAM TURBINES FOR COMBINED POWER AND HEAT GENERATION.

The design and heat diagram of two types of special turbines for heat and power plants are outlined. The first type contains a condensing, reheat, extraction turbine, 125/135 Mw, for the steam condition of 138 bar 535/535°C while heat is extracted from the turbine at 125 Gcal per hour maximum. The other type is a back-pressure turbine, 113 Mw, designed for the steam condition of 148 bar, 535/535°C. The heat diagram of a nuclear heat and power plant under study with turbo-set for the saturated input steam and power output of 117 Mw is presented.

Draby, J. Skoda Works, Pilsen, Czech. Stanek, M. *World Energy Conf. 8th, Trans. Bucharest, Rom, Jun 28-Jul 2 1971* v 5, pap 3.1-208, 17 p. Available from Rom Natl Comm of the World Energy Conf, Bucharest, 1972.

ECONOMIC ASPECTS OF COMBINED GAS-STEAM CYCLES APPLIED TO INDUSTRIAL HEAT AND POWER PLANTS.

A survey of gas-steam cycles applicable in industrial heat and power plants with back-pressure turbines is presented. Of six basic cycles for detailed technical and economic investigation, a cycle is chosen in which the outlet gases of a gas turbine are utilized as air required for combustion in a steam boiler and the heat of boiler flue gas is utilized in the feed heating system. Independent operation of steam and gas parts is possible. For the selected gas steam cycle, a computer program has been prepared to determine the effect of the basic parameters on system profitability. As the profitability criterion, the critical specific fuel consumption index per electric energy unit produced in an equivalent modern condensing plant is accepted. The profitability indices are given as calculation results as a function of the basic variable parameters.

Krajewski, Rudolf Gdansk Tech Univ, Poli; Marecki, Jacek. *World Energy Conf. 8th, Trans. Bucharest, Rom, Jun 28-Jul 2 1971* v 6, pap 3.3-66, 20 p. Available from Rom Natl Comm of the World Energy Conf, Bucharest, 1972.

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Technology utilization ideas for the 70's and beyond. Edited by P. W. Forbes [and] P. Dergarabedian. Tarzana, Calif., AAS Publications Office [1971]

xiv, 315 p. illus. 25 cm. (AAS science and technology series, v. 26)

An American Astronautical Society publication. Proceedings of a special AAS/AIAA technical event, held October 30, 1970 at Winrock, Arkansas at the invitation of Governor Winthrop Rockefeller. P. 213 -

RANKINE CYCLE POWER SYSTEMS FOR AUTOMOTIVE APPLICATION

Jerry A. Peoples
George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

Abstract

The importance of developing effective, efficient steam propulsion systems is recognized as a mandatory step in our country's technology applications to environmental improvements. With this in mind, several years of effort have been placed into the exploration of new concepts related to rankine cycle engine systems. From this effort, several concepts believed to be unique have emerged. These include a variable pressure boiler (VPB) passive pressure and temperature control, and hermetically-sealed engine configurations.

The entire problem of a steam automotive system is manifested in the control required to maintain boiler pressure and temperature under varying loads, throttle changes, and engine cutoff settings. The control approach taken by current steam car designs is based upon a fuel rate proportional to the pressure error between command and actual pressures. Speed and power are controlled by the throttle which can be varied manually by the operator. The VPB concept overcomes the control problems of the conventional fixed boiler pressure concepts.

A passive control concept is discussed which allows the boiler pressure to seek its own equilibrium level. The throttle is eliminated. The block diagram for conventional steam system operation is reviewed and compared with the VPB block diagram. Advantages of the VPB concept are discussed in terms of passive pressure control and system performance. Finally, a provocative idea of passive temperature control is introduced. Passive temperature control is a natural consequence of a VPB.

A71-13035 Organic Rankine cycle power system performance and status. M. W. Reck and R. W. Niggemann (Sundstrand Corp., Rockford, Ill.). In: Power Sources Symposium, 24th. Atlantic City, N.J., May 19-21, 1970. Proceedings. (A71-13026-03-03) Symposium sponsored by the U.S. Army. Red Bank, N.J., PSC Publications Committee, 1970, p. 55-61.

Discussion of the design and early development efforts of an organic Rankine cycle power system for commercial on-site electrical power generation as well as on-site heating and cooling requirements. The considerations involved in the design of a natural gas fired total energy system capable of delivering 40 kW of electrical power and 500,000 Btu/h of thermal energy suitable for either heating or cooling purposes are discussed. The predicted performance of the system and its major components are presented. G. R.

N70-20572*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio. CYCLE EFFICIENCY OF AIR-COOLED STEAM POWERPLANTS

Richard J. Weber Washington Mar. 1970 18 p (NASA-TM-X-1970: E-5420) Avail: CFSTI CSCL 10B

Steam powerplants for mobile applications such as automobiles must use air-cooled condensers to reject waste heat. A preliminary study is made of the effect of major design parameters on the efficiency of various steam cycles of this type. The efficiency of a typical system of the type usually considered for steam cars can be improved by a factor of 1.3 through use of a more complex system that employs an air turbine.

Author

A70-25371 Performance of a 35 HP organic Rankine cycle exhaust gas heat powered system. Erwin Lodwig (Fairchild Hiller Corp., Stratos Div., Bay Shore, N.Y.). Society of Automotive Engineers, Automotive Engineering Congress, Detroit, Mich., Jan. 12-16, 1970, Paper 700160. 32 p. Members, \$1.00; nonmembers, \$1.50. USAF-sponsored research.

An organic Rankine cycle system utilizing waste exhaust gas heat from a 30 KW gas turbine generator set has been built and tested. Utilizing a new fluorocarbon fluid, the system furnishes 18.9 KW of additional electrical power output along with 120,000 BTU/hour for air heating and 190,000 BTU/hour for water heating for environmental control. The primary gas turbine engine fuel control furnishes the speed control for the mechanically locked-in Rankine turbine and permits fuel saving operation under power sharing conditions from full load to idle conditions. This system concept provides electrical energy output at a fuel consumption rate approaching that of the diesel set but at a small fraction of the diesel set weight.

(Author)

N71-28104*# Santa Clara Univ. Calif. School of Engineering. APPLICABILITY OF FLUIDIC CONTROLS TO A RANKINE CYCLE AUTOMOTIVE ENGINE Final Report

R. Ian Murray, Stein Weissenberger, and Eugene J. Fisher Dec. 1970 52 p (NASA-CR-119006) Avail: NTIS CSCL 13G

Rankine cycle performance with three different fluids is evaluated: water, CP-34, and freon TF. Performance with CP-34 and a reciprocating expander using fluidic flow diverters instead of mechanical valves is examined. The control criteria for the boiler and feed pump are also investigated. It is concluded that the use of fluidic flow diverters in place of mechanical valves is not feasible and that any further effort to apply fluidic controls to automotive engines should be in information sensing and processing rather than in direct control of power.

Author

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Technology utilization ideas for the 70's and beyond. Edited by F. W. Forbes [and] P. Dergarabedian. Tarzana, Calif., AAS Publications Office [1971]
xiv, 315 p. illus. 25 cm. (AAS science and technology series, v. 26)
An American Astronautical Society publication. Proceedings of a special AAS/AIAA technical event, held October 30, 1970 at Winrock, Arkansas at the invitation of Governor Winthrop Rockefeller. P.29-

NONPOLLUTING CENTRAL POWER STATIONS*

F. L. Robson and A. J. Giramonti
United Aircraft Research Laboratories
East Hartford, Connecticut 06108

One of the most promising advanced-cycle power systems consists of a combined gas turbine-steam turbine (COGAS) system in which the hot exhaust of the gas turbine is used to raise steam in an unfired waste-heat recovery boiler. The gas turbine used in this system would be an evolution of current turbomachinery and would utilize aerodynamic and blade cooling concepts and blade materials which are now used or proposed for use in advanced aircraft gas turbines. Approximately two-thirds of the power output would come from the gas turbine and one-third from the steam turbine.

Using technology judged to be available by 1980, the COGAS system could achieve overall station efficiencies of approximately 55%, with the potential of even higher efficiencies with more advanced technology. Conventional fossil-fuel power stations currently have station efficiencies of approximately 38%, and projections for future power stations indicate only minor increases.

A73-25982 * # Review of the NASA Brayton System Technology Program. H. Rothen (NASA, Office of Advanced Research Technology, Washington, D.C.). In: Energy 70: Proceedings of the Fifth Intersociety Energy Conversion Engineering Conference, Las Vegas, Nev., September 21-25, 1970. Volume 1. (A73-25976 11-03) Hindsdale, Ill., American Nuclear Society, 1972, p. 4-1 to 4-5.

Summary of the research work accomplished on the Brayton space power system during the 1962-1972 period. It is shown that a great amount of Brayton system technology has been developed over this period

N72-10830# Mitre Corp., McLean, Va.
A SURVEY OF PROPULSION SYSTEMS FOR LOW EMISSION URBAN VEHICLES
W. E. Fraize and R. K. Lay Sep. 1970 118 p refs Sponsored by DOT

(Contract F19628-68-C-0386)
(PB-200144; UMTA-TRD-52-70-2; M70-45) Avail: NTIS CSCL 13F

An overview is presented of low and negligible emission urban vehicle technology. Propulsion systems suitable for low emission urban vehicles are described. The state-of-the-art of low emission systems is surveyed by direct contact with active development efforts in industry; the more promising areas for future development are reviewed. Exhaust emissions from fossil-fueled heat engines are summarized. A computer program was developed to demonstrate the effect of the various route cycle and vehicle parameters on required power and vehicle speed; results are presented for a typical small urban bus.

Author (GRA)

PB-196 392
United Aircraft Corp., East Hartford, Conn.
Research Labs.
TECHNOLOGICAL AND ECONOMIC FEASIBILITY OF ADVANCED POWER CYCLES AND METHODS OF PRODUCING NONPOLLUTING FUELS FOR UTILITY POWER STATIONS.

Final rept. 1 Jul 69-31 Dec 70.

F. L. Robson, A. J. Giramonti, G. P. Lewis, and G. Gruber Dec 70, 569p. *UARL-1970855-13

APTD-0661

Contract CPA-22-69-114

Descriptors: (*Air pollution, *Sulfur dioxide), (*Electric power plants, Air pollution), (*Desulfurization, *Fossil fuels), (*Coal, Desulfurization), Steam electric power generation, Electric power generation, Gas turbine power generation, Operating costs, Engineering drawings, Economic analysis, Petroleum.

Identifier: COGAS power system.

Analytical studies have been made to identify the technical and economic factor that will govern future selection of fuel cleanup processes and advanced-cycle central power stations which, in combination, will be capable of producing electric power at the lowest possible cost while reducing substantially the emissions of sulfur oxide pollutants resulting from the combustion of high-sulfur coal and residual fuel oil. The technical approach was based upon technology currently available, but possibly not reduced to commercial practice as well as technology judged attainable for commercial use within the next ten and twenty years. This approach included evaluations of current and projected: fossil-fuel desulfurization and conversion processes, current and advanced-cycle central power stations, and integrated fuel cleanup and power stations. (APCO abstract)

A71-13034 Reciprocating Rankine cycle engine developments. E. F. Doyle, R. J. Raymond, and T. LeFeuvre (Thermo Electron Corp., Waltham, Mass.). In: Power Sources Symposium, 24th, Atlantic City, N.J., May 19-21, 1970, Proceedings. (A71-13026 03-03) Symposium sponsored by the U.S. Army. Red Bank, N.J., PSC Publications Committee, 1970, p. 51-54.

Discussion of development tests which demonstrate the suitability of a reciprocating expander of conventional design and materials for an organic Rankine-cycle system. The developments considered include single-cylinder expander testing using Monsanto Cp-34 (Thiophene, C₄H₄S) fluid. A parallel effort on a similar test loop has been devoted to expander testing using various refrigerants. It is pointed out that on the basis of the results obtained Thermo Electron is proceeding with the prototype systems phase of development of Rankine-cycle powerplants using organic working fluids. G.R.

N69-29908* General Electric Co., Cincinnati, Ohio. Nuclear Systems Programs.

THREE-STAGE POTASSIUM VAPOR TURBINE FABRICATION AND ASSEMBLY Final Report

H. E. Nichols, R. W. Fink, and W. F. Zimmerman 22 May 1969 207 p refs

(Contract NAS3-8520)

(NASA-CR-72501; GESP-223) Avail: CFSTI CSCL 21H

The three-stage potassium test turbine includes (1) refractory metal forgings in the fabrication of the first two stage wheels; (2) refractory-metal rotor blades in stages two and three; and (3) material specimens in the casing downstream of the last rotor wheel for observation of possible impingement erosion from liquid slung off the rotor periphery. The report provides a discussion of the significant fabrication problems and accomplishments, and presents a photographic description of the actual physical hardware, along with a description of turbine assembly, and a record of all hardware weights, dimensions, etc. prior to initiating potassium testing. It discusses only the configuration employing tip shrouded rotor configuration. Author

Economic Feasibility of the Steam Ammonia Power Cycle

Issued July, 1969

R&D Report No. 47 (2)—Final Report

Contractor: The Franklin Institute Research Laboratories

Refer to: Titled report and PB-184331

Price: \$6.00 NTIS

N70-13927# Politecnico di Torino (Italy). Centro Studi Motorizzazione Agricola.

POSSIBILITIES AND PROBLEMS OF GAS TURBINE APPLICATION FOR GROUND MOTION MACHINES [POSSIBILITA E PROBLEMI DELL'APPLICAZIONE DELLE TURBINE A GAS ALLE MACCHINE PER MOVIMENTO TERRA]

Gianni Rigamonti and Fiorenzo Morra (Fiat) Assoc. Tec. Automobile Jun. 1969 19 p refs In ITALIAN Sponsored by Consiglio Naz. delle Ric. Its Ric. ATA, Quaderno 69, Suppl. to No. 6

(Publ-18) Avail: CFSTI

The present state of development of gas turbine engines for surface propulsion through a mechanical transmission is outlined. The space/power and weight/power relationship and the operational characteristics are discussed, as well as the utilization of the prime mover as a power supply to the auxiliaries. For gas turbine drives special systems of motor braking must be devised and new problems are encountered in installation, noise level, air filtering and exhausts. ESRO

N70-14489# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

CERTAIN DESIGN PECULIARITIES OF AUTOMOTIVE GAS TURBINES

Yu. I. Frieman et al 22 May 1969 20 p refs Transl. into ENGLISH from Akad. Nauk SSSR, Izv. Energ. i Transp. (USSR), no. 2, 1968 p 40 47

(AD-694842; FTD-MT-24-521-68) Avail: CFSTI CSCL 21/5

This paper examines design characteristics of automobile gas-turbine engines: the engines almost always operate at considerably below rated power and over a wide rpm range and they are often shifted from mode to mode and therefore must have good pickup. A twin-shaft turbine with heat exchanger is considered, but almost everything discussed applies to any automobile gas-turbine engine. It is shown that the rated pressure increase in the compressor must ensure minimum specific fuel consumption under average operating conditions. Selection of the basic engine parameters on the basis of minimum total cost per unit of transport work is proposed as a general approach to design. Author (TAB)

N71-13767* Scripta Technica, Inc., Washington, D.C.

FUNDAMENTALS OF THE THEORY OF TURBINES OPERATING ON WET STEAM

I. I. Krilov et al NASA Nov. 1970 273 p refs Transl. into ENGLISH of the book "Osnovy Teorii Vlazhnoparovykh Turbin" Leningrad, Mashinostroyeniye, 1968 p 1-259

(Contract NASw-1694)

(NASA-TT-F-611) Avail: NTIS CSCL 20D

The theoretical and experimental condensation processes and gas dynamics of two-phase flows in wet-steam turbines are studied. Problems of gas dynamics are examined as applied to the motion of moisture droplets of various sizes in the flow of steam. Particular attention is paid to clarification of physical phenomena in flow passages of the turbine. The motion of droplet and films are studied for solving practical problems, i.e., determining losses and separation of moisture. Author

70N76531 PH-86-67-109 68/C5/15 168 PAGES UNCLASSIFIED DOCUMENT
 STUDY OF UNCONVENTIONAL THERMAL, MECHANICAL, AND NUCLEAR
 LOW-POLLUTION-POENTIAL POWER SOURCES FOR UREAN VEHICLES SLMMARY
 REPORT
 A/CHEANEY, E. S.; B/CRESWICK, F. A.; C/FISHER, R. D.; C/HCESS, J.
 A.; E/TRAYSER, L. A.
 BATTILLE MEMORIAL INST., COLUMBLS, CHIC.
 /*AIR POLLUTION/*AUTOMOBILE ENGINES/*SYSTEMS ENGINEERING/ BRAYTON
 CYCLE/ NUCLEAR ENERGY/ PROPULSION SYSTEM PERFORMANCE/ RANKINE CYCLE/
 STIRLING CYCLE/ THERMOELECTRIC POWER GENERATION

N64-27117 General Electric Co., Schenectady, N.Y. Large
 Steam Turbine-Generator Dept.

SUMMARY OF COMMENTS ON 100,000 KW GAS TUR-
 BINE-GENERATOR

C. E. Kilbourne In Inst. for Defense Analysis Proc. of the IDA
 Pulse-Power Conf., Feb. 4-5, 1963, Vol. IV Jul. 1963 p 101-
 104 (See N64-27101 19-06)

The 100,000-kw gas-turbine-generator units are being
 built for peaking service in electric utility systems. These units
 are conservatively rated 100,000 kw at 80° F ambient inlet air
 temperature, and 1,000-ft altitude, when burning liquid jet-
 aircraft fuel. With ambient temperatures of 20° F, the output
 can be increased to 125,000 kw. Sixty-cycle/sec a.c. gener-
 ators are being furnished with these units; however, the gas
 turbine may also be used to drive large acyclic d.c. generators.
 A description of the 100,000-kw gas turbine generator and
 the electric generator is presented along with the advantages
 of this gas-turbine-generator unit.

R.T.K.

III. ENERGY AND POWER STORAGE AND TRANSMISSION

A. STORAGE

MECHANICAL AND BATTERY STORED ENERGY SYSTEMS FOR MEETING UNINTERRUPTIBLE AND BUFFERED ELECTRIC POWER NEEDS.

G.E. Comeau.

IEEE Trans Industry Applications, v. IA-10, no. 2,
Mar./Apr. 1974, p. 209-212.

Abstract—Mechanical or battery-stored energy systems are used when an uninterruptible or buffered power system is required. Seven different types of systems available are described and compared.

ENERGY STORAGE (I): USING ELECTRICITY MORE
EFFICIENTLY. A.L. Robinson.
Science, v. 184, May 17, 1974, p. 785-787.

Article discusses pumped storage, compressed
air storage, and storage batteries.

ENERGY STORAGE (II): DEVELOPING ADVANCED TECHNOLOGIES.
A.L. Robinson.
Science, v. 184, May 24, 1974, p. 885-887.

Article discusses superconducting magnetic,
superflywheel, hydrogen, and thermal energy storage.

1973

IX Intersociety Energy Conversion Engineering Con-
ference, 8th Philadelphia, Pa., 1973.

Proceedings. New York, American Institute of

Aeronautics and Astronautics [1973]

847 p. illus. 29 cm.

Held at: University of Pennsylvania, Philadel-
phia, Pa., August 13-16, 1973.

Sponsored by: American Institute of Aero-
nautics and Astronautics [and others]

Thermal Losses in Gas-Charged Hydraulic Accumulators - D. R. OTIS..... 198

Improving the Energy Storage Capacity of Hydraulic Accumulators - M. P.

SHERMAN, B. V. KARLEKAR..... 202

Achieving High Energy Efficiency for Urban Transportation Through

Hydrostatic Power Transmission and Energy Storage - P. E. TARTAGLIA.... 232

Heat-Storage Wells for Conserving Energy and Reducing Thermal Pollution -

C. F. MEYER, D. K. TODD..... 428

Compressed Air Energy Storage System Characteristics - R. DECHER..... 433

(WASH-1281-4) ENERGY TRANSPORTATION, DISTRIBUTION, AND STORAGE, Subpanel Report IV Used in Preparing the AEC Chairman's Report to the President. (USAEC, Washington, D. C.). 1973. 158p. Dep. NTIS \$11.00.

Five year R and D program objectives in transportation and distribution are: (1) continue development of increased-capacity ac and dc overhead power transmission systems by doubling the present capacity by 1985, and achieving a multiplication of 4 to 10 times by the year 2000; (2) to continue the development of reliable and lower-cost underground transmission systems capable of matching future overhead systems in both power capacity and voltage; (3) to develop advanced methods and equipment for systems security and control that will improve reliability and efficiency of generation, transmission, and distribution; and (4) to analyze electrical energy transportation systems development in order to identify the more desirable growth options, and to pursue fundamental investigations that have potential for long-term (beyond 2000 AD) application. Five-year objectives in the area of energy storage are: (1) to support completion of bench models of Na/S and Li/S batteries; (2) to support completion of a 10-mwh pilot model of an advanced battery (Na/S or Li/S); (3) to provide surveillance of Zn/Cl₂ battery development and support fundamental research in electrochemistry; to provide engineering development of superconducting energy storage magnets and flywheels; and to provide for economic assessment of batteries and other storage systems. (auth)

N70-26431# Varta A. G., Frankfurt am Main (West Germany):
METHODS OF ACCUMULATION OF ELECTRIC ENERGY
[METHODES D'ACCUMULATION DE L'ENERGIE
ELECTRIQUE]

Karl Joachim Euler /in ESRO Space Power Systems. Energy Storage Sep. 1969 p 1-21 refs In FRENCH (See N70-26430 12-03)

Avail: CFSTI

Besides conventional accumulators, new methods for storing electric energy e.g. electrochemical, mechanical, thermal and electromagnetic methods, have recently been studied. In the electrochemical field there are 'exotic' accumulators, liquid redox batteries, regenerative H sub 2/O sub 2 fuel cell systems, and fuel cell systems in which regeneration is due to thermal-, photo- or X-ray decomposition of the reaction products. A few mechanical accumulators have been based on gyrostats and, using the energy of a volume of highly compressed gas, it is possible to envisage a compressor-engine system. One could also imagine storing energy on the defects of crystal lattices. Studies have also been carried out on energy storage in ceramic materials, especially in gravel layers. Purely electric systems are represented by capacitors or by the storage of space charges in electrets. A certain amount of energy is also stored in the magnetic fields of ferromagnetic magnets, an effect which, when amplified, will have a great importance in connection with superconducting coils.

(Author (ESRO))

TITLE: New Frontiers in Energy Storage
AUTHOR: McCallum, J.: Faust, C.L.
CORPORATE AUTHOR: Battelle, Columbus Laboratories
PUBLICATION DESCRIPTION: Battelle Research
Outlook, 4(1), 26-29
PUBLICATION DATE: 1972

Article discusses various methods of storing energy.

N65-24860# Oklahoma State Univ., Stillwater. School of Electrical Engineering

PROCEEDINGS OF THE 2ND ANNUAL ENERGY CONVERSION AND STORAGE CONFERENCE, OCT. 12-13, 1964
Bill Linville, ed. [1964] 74 p refs Available from Oklahoma State Univ. \$5.00

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1. STORAGE AS AN ECONOMIC ALTERNATIVE FOR CONVENTIONAL PEAKING CAPACITY R. E. Thornton and T. Hoke (Okla. Gas and Elec. Co.) 4 p refs (See N65-24851 14-03)
2. ENERGY STORAGE BY HYDRAULIC MEANS THE TAUM SAUK PROJECT G. P. Gamble (Union Elec. Co.) 14 p refs (See N65-24852 14-03)
3. ECONOMICS OF ENERGY STORAGE J. E. O'Neil (Westinghouse Elec. Corp.) 8 p refs (See N65-24853 14-03)
4. INVERSION IN THE MEGAWATT RANGE J. H. Harlow (Allis-Chalmers Mfg. Co.) 7 p refs (See N65-23854 14-03)
5. FUEL CELL RESEARCH AT OKLAHOMA STATE UNIVERSITY H. Jack Allison 6 p ref (See N65-24855 14-03)
6. THE ZOZ SYSTEM E. B. Cupp (Eagle-Picher Co.) 2 p (See N65-24856 14-03)
7. INTEGRATING THE FUEL CELL POWERPLANT INTO THE ELECTRIC UTILITY INDUSTRY R. J. Borup (Pratt and Whitney Aircraft) 9 p (See N65-24857 14-03)
8. NEED FOR BASIC RESEARCH IN THE FIELD OF ENERGY CONVERSION L. J. Long (Army Eng. and Dev. Labs.) 8 p refs (See N65-24858 14-03)
9. PROBLEMS AND PROGRESS IN CONTROL OF THERMONUCLEAR FUSION FOR ELECTRIC POWER PRODUCTION A. A. Dangel (Tex Univ.) 8 p refs (See N65-24859 14-03)
10. THE FEASIBILITY OF MHD POWER GENERATION W. S. Emmerich (Westinghouse Elec. Corp.) 6 p (See N65-24860 14-03)

N64-29484 Oklahoma State U., Stillwater
 PROCEEDINGS OF A CONFERENCE ON ENERGY CON-
 VERSION AND STORAGE
 Jul. 1964 111 p refs Conf. held 28 Oct. 1963. Stillwater,
 Okla. Okla. State U.: \$5.00

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 29487 21-06)
4. A REPORT ON SOME OF THE EXPERIMENTAL
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 64 (See N64-29488 21-06)
5. EXPERIMENTAL WORK TO DATE ON ENERGY CON-
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6. ENERGY STORAGE SYSTEM CONCEPTS, AD-
 VANTAGES, LIMITATIONS, AND EFFICIENCIES H. Jack
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7. METHODS AND ECONOMICS OF HIGH PRESSURE
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 WITH A SOLAR TO ELECTRICAL SYSTEM WITH INTER-
 MEDIATE ENERGY STORAGE Claude M. Summers p 89-
 95 (See N64-29491 21-06)

ENERGY STORAGE PROBLEMS.

F. Daniels.

Solar Energy, v.6, no.3, July/Sept.1962, p.78-83.

Sections on mechanical storage, storage batteries,
 fuel cells, hydrogen fuel (electrolysis), chemical
 and photochemical energy storage, heat storage, and
 electrical network.

N64-27101 Institute for Defense Analyses, Washington, D.C.
 Research and Engineering Support Div.
 PROCEEDINGS OF THE IDA PULSE-POWER CONFERENCE,
 FEBRUARY 4-5, 1963, VOLUME IV Study S-104
 Jul. 1963 152 p refs Unclassified Papers on Capacitor En-
 ergy Storage, Electrochemical Pulse Systems, and Dynamic
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 (ARPA SD-50)
 (IDA/HQ-63-1415; AD-434752)

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13. PRELIMINARY REVIEW OF AN AMALGAM FUEL
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 N64-27113 19-06)
14. ENERGY AND HIGH PULSE GENERATION W. Wright
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 N64-27114 19-06)
15. ENERGY GENERATION OR LONG DURATION
 STORAGE BY DYNAMIC METHODS L. A. Kilgore, W. Wright,
 and C. H. Church (Westinghouse Electric Corp.) p 97-98 (See
 N64-27115 19-06)
16. PROPOSALS FOR THE GENERATION OF HIGH
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17. SUMMARY OF COMMENTS ON 100,000 KW GAS
 TURBINE-GENERATOR C. E. Kilbourne (General Electric
 Co.) p 101-104 (See N64-27117 19-06)
18. MOTOR-GENERATORS AND HIGH MAGNETIC
 FIELDS C. G. Adams (Jackson and Moreland, Inc.) p 105-119
 (See N64-27118 19-06)
19. ELECTROMECHANICAL PULSERS E. Levi (Poly-
 technic Inst. of Brooklyn) p 120-141 refs (See N64-27119
 19-06)

ELECTROCHEMICAL

1974

Energy Policy, v.2, no.1, Mar.1974, p.55-

Fuel cells: past, present and future
A.D.S. Tantram

Some of the euphoria of the early 1960s, which led to over optimistic predictions of the future of fuel cells, has now worn off.

Mr Tantram charts the development of fuel cells from early laboratory experiments to the highly efficient, but expensive cells used in the Apollo space programme and assesses their future commercial prospects.

1974

MODULAR FUEL CELL PROGRAM ADVANCES.

Aviation Wk & Space Tech., Jan.7,1974, p.54-55.

Fuel cell powerplant includes individual modules combined on a half-acre site into a 26 mw generating system. Units are truck transportable and can be installed with conventional construction equipment. A joint program by Pratt & Whitney Aircraft and nine utility companies.

Low Wattage Hydrogen - Air Fuel Cells.

O. J. Adhart.
Engelhard Minerals and Chemicals Corp East Newark N J
Systems Dept 1974, 49p USAMERDC-21583
AD-778 550/4WE PC\$3.25/MF\$1.45

Low Wattage fuel cells based on the matrix type phosphoric acid cell are discussed. Nominal ratings of 5-watts or less are considered. Bottled hydrogen or metal hydrides are used as fuel. Two approaches are taken. One relying on a conventional bipolar cell design with water removal by the air stream. In an alternate approach, metal hydrides are integrated with the fuel cell into a device resembling a primary battery. Hydrogen is generated by reaction of the hydride fuel with the fuel cell product water. Power sources based on the phosphoric acid cell exhibit favorable life characteristics and power densities comparable to or exceeding low rate primary batteries.
(Author)

FUEL CELLS: FACT & FICTION.

N. R. Iannmartino.

Chem. Engineering, v.81, no.11, May 21,1974,
p62,64.

Though many firms once developing fuel cells have now dropped out completely or trimmed their efforts to the bones, at least two ventures are moving toward the commercial market-place.

(AD-76629-7) RESEARCH ON ELECTROCHEMICAL ENERGY CONVERSION SYSTEMS. Interim Technical Report No. 3, October 1972-April 1973. Adams, A. A.; Foley, R. T.; Goodman, R. M. (American Univ., Washington, D. C.). Jun 1973. Contract DAAK02-72-C-0084. 68p. NTIS \$3.50.

The research on electrochemical energy conversion systems has involved work on two tasks: a search for electrolytes alternative to phosphoric acid for direct and indirect hydrocarbon-air fuel cells, and a study of the corrosion characteristics of electrolytes for intermediate-temperature hydrocarbon-air fuel cells. The work during this reporting period was concentrated on the first task. Two alternative electrolytes, trifluoromethanesulfonic acid monohydrate and dichloroacetic acid, representative of two classes of compounds, were studied in some depth. The first compound shows definite promise as an alternative electrolyte. It is physically and electrochemically stable up to 135°C for periods of time up to six weeks. The limiting current density for the oxidation of propane at 135°C is approximately 15 times that observed in H_2PO_4 at the same temperature. Certain problems associated with the use of dichloroacetic acid were encountered. These were interpreted in terms of the state of the "unbound" water in the electrolyte. (GRA)

The development and practical application of fuel cells. F. T. Bacon, T. M. Fry. Proc. R. Soc. A (GB), vol. 334, no. 1599, p. 427-52 (1973). (received: Aug. 1973)

The author describes initially the principle of operation of a fuel cell and this is followed by a detailed account of the alkaline fuel cell, first with respect to choice of electrolyte and working temperature and secondly choice of materials and electrode design. A description is given of the hydrogen-oxygen fuel cell system used in the Apollo space flights, and the results obtained. Acid fuel cell development is also considered and mention is made of recent developments with acidic ion exchange membranes as electrolyte and a brief description is given of the early design used in the Gemini space flights. The terrestrial applications of fuel cells, energy storage, and synthetic fuels are topics also considered. (16 refs.)

N74-13766# Energy Research Corp., Bethel, Conn. HYDROGEN GENERATOR Final Technical Report Edward S. Tillman, Jr. Aug. 1973 66 p refs (Contract DAAK02-71-C-0397; DA Proj. 1G6-63702-DG-10) (AD-767402; ERC-0397F) Avail: NTIS CSCL 10/2

A compact hydrogen generator for small liquid hydrocarbon fueled fuel cells was designed, built and partially tested. The basic generator embodies the steam reforming of liquid fuels available to the military. Provisions have been made for sulfur removal and hydrogen purification can be achieved with a palladium-silver hydrogen separator. Extensive testing on the reforming unit was conducted and results reported. An electronic control system for startup and steady state operation was designed and built but was not fully integrated with the reformer. Emphasis throughout the study was placed on miniaturizing components. Author (GRA)

N74-12744# Pratt and Whitney Aircraft, East Hartford, Conn. THE 1.5-KW FUEL CELL POWERPLANT Final Report, 1 Jul. 1971 - 31 Dec. 1972

Anthony J. DeCasperis and H. Leigh Ferguson 2 Apr. 1973 119 p refs (DA Proj. 1G6-63702-DG-10; Contract DAAK02-70-C-0518) (AD-767302; PWA-4704) Avail: NTIS CSCL 10/2

Four advanced development model 1.5kW fuel cell power plants were delivered to the Army for evaluation. The delivery configuration power plant weighs 292 lbs. and has a volume of 9.7 cubic feet. Startup and Operation are fully automatic and the power plant operates on JP-4 fuel with a specific fuel consumption of less than 2.2 lbs/kWh. Output voltage is adjustable from 26 to 34 volts at any output from 0 to 1.5kW. The power plant consists of four subsystems, a regenerative thermal cracker, which converts logistic fuel to hydrogen, an acid fuel cell power section which generates dc power from hydrogen and air, a voltage regulator and an automatic control system. A core technology program was conducted to develop the cracker voltage regulator and automatic control unit. Limited development of the power section, which is based on commercial technology fuel cells, to tailor the design to Army requirements was also conducted. The program culminated with development testing of a complete power plant and delivery of four power plants to the Army. Author (GRA)

N74-20710# Pratt and Whitney Aircraft, East Hartford, Conn. THE 1.5-KW FUEL CELL POWERPLANT CATALYST INVESTIGATION Supplement to Final Report, 1 Oct. 1972 - 30 Jun. 1973

Donald R. McVay Jul. 1973 29 p (Contract DAAK02-70-C-0518; DA Proj. 1G6-63702-DG-10) (AD-774274; PWA-4704A-Suppl) Avail: NTIS CSCL 10/2

The objective of this program was to improve the powerplant thermal cracker catalyst and to define its performance characteristics. Five areas were investigated: (1) the type of catalyst ceramic support and the level of nickel loading, (2) the effect of shock and vibration on performance, (3) performance on leaded gasoline and JP-4, (4) the effect of high sulfur fuel on performance, and (5) endurance on leaded gasoline. The results of the study are given in the report. GRA

1973

E. F. SVERDRUP, C. J. WARDE and R. L. EBACH, Westinghouse Research Laboratories, Pittsburgh, Pennsylvania 15235, U.S.A.

Design of high-temperature solid-electrolyte fuel-cell batteries for maximum power output per unit volume: *Energy Conversion* 13, 129-141 (1973).

Summary—In a design of an integrated fuel-cell power system, conceived by Westinghouse under contract to the Office of Coal Research, it is important to maximize the power output per unit volume of fuel-cell batteries, because of heat-release and material-conservation considerations. A battery-design study has been completed, in which the optimum film lengths on a tubular substrate have been calculated for a range of values of electrolyte and interconnection resistivity-thickness products and electrode resistivity-thickness quotients. The analysis shows that power densities of greater than 8 kW ft^{-2} of battery volume would be possible, assuming that the batteries operate at 80 per cent electrical efficiency and are constructed on tubes, one-half inch in diameter, which are spaced in the manner of tubes in a shell and tube heat exchanger.

Key words: Battery design fuel cell optimization power density solid electrolytes zirconia

High voltage fuel cell assembly --- performance tests of experimental units Final Report, May 1972 - Jan. 1973 Energy Research Corp., Bethel, Conn. CAMF, R. W. BAKER, B. S. JAN. 1974 44 PAGES AD-774820 SEC-14557 AVAIL- NTIS
•HYDROGEN OXIDE FUEL CELLS, PERFORMANCE TESTS HIGH VOLTAGES, PHOSPHORIC ACID, SYSTEMS ENGINEERING, TEMPERATURE EFFECTS CO3 874-21696 *

N73-33009# Naval Ship Research and Development Center, Annapolis, Md.
HIGH-POWER DENSITY HYDRAZINE FUEL CELLS
D. E. Icenhower and H. B. Urbach Jun 1973 17 p refs (SF35431005)
(AD-764530, NSRDC-3934; NSRDC-27-381) Avail: NTIS CSCL 10/2

A hydrazine-oxygen fuel cell was operated under moderate conditions of temperature and concentration at power densities up to 600 watts per square foot (1000 amperes per square foot at 0.6 volt). At this output, a power efficiency of 32% was obtained at 70C at less than molar hydrazine concentration. Power efficiencies exceeding 48% were obtained over a power density range from 40 to 200 watts per square foot by matching the temperature and hydrazine concentration optimally to the electrical load. The three major components of cell polarization were examined. Critical resistance losses were minimized by use of a 0.010-inch asbestos matrix which was more than adequate to prevent leakage of oxygen to the anode at moderate differential pressures. A projected cell thickness of 0.1 inch and a power density of 200 watts per square foot correspond to a calculated stack power-volume ratio of 16 kilowatts per cubic foot (Modified author abstract) GRA

676 b

TK 1973
 2896 Intersociety Energy Conversion Engineering Conference, 8th Philadelphia, Pa., 1973.
 .155 Proceedings. New York, American Institute of Aeronautics and Astronautics [1973]
 1973 847 p. illus. 29 cm.
 Held at: University of Pennsylvania, Philadelphia, Pa., August 13-16, 1973.
 Sponsored by: American Institute of Aeronautics and Astronautics [and others]

The Lockheed Power Cell - H. J. HALBERSTADT..... 63
 High Power Density Hydrazine Fuel Cells - D. E. ICENHOWER, H. B.
 URBACH..... 67

Electricity for Developing Areas via Fuel Cell Power Plants - J. M. KING,
 S. H. FOLSTAD..... 111
 High Energy Density Silver-Hydrogen Cells for Space and Terrestrial
 Applications - R. J. HAAS, D. C. BRIGGS..... 116

1972

TK Institute of Electrical and Electronics Engineers.
 6540 1972 IEEE International convention digest.
 .I 445 New York, 1972.
 1972 559 p. illus. 28 cm.
 "Synopsis of Papers Presented at the 1972
 IEEE International Convention March 20-23, 1972,
 New York, N. Y."
 "IEEE cat. no. 72 CHO 581-9 IEEE."

Batteries and Fuel Cells in Future
 Energy Handling, R. P. Hamlen and
 H. A. Christopher..... 148

A73-17841 # Fuel cells for improved electrical power
 supply. C. C. Morrill (United Aircraft Corp., Pratt and Whitney
 Aircraft Div., East Hartford, Conn.). American Institute of Aero-
 nautics and Astronautics, Annual Meeting and Technical Display,
 9th, Washington, D.C., Jan. 8-10, 1973, Paper 73-82. 7 p. Members,
 \$1.50; nonmembers, \$2.00.

Current commercial fuel cell technology and the requirements
 of utility applications lead to a fuel cell system design which is
 modular in configuration and is composed of three major sub-
 systems. The subsystems include a fuel processor, a fuel cell power
 section, and an inverter. Fuel cell operational characteristics are
 discussed, giving attention to its high efficiency, its environmental
 characteristics, the load response, and the operational modes. G.R.

TK Gregory, D P
 2931 Fuel cells [by] D. P. Gregory. London,
 .G72 Mills & Boon Limited [1972]
 69 p. illus. 22 cm.

Distributed in the United States by Crane,
 Russak & Co., Inc., New York.

TK Intersociety Energy Conversion Engineering
2896 Conference, 7th, San Diego, Calif., 1972.
I 55 Proceedings. Washington, D. C., American
1972 Chemical Society, 1972.

1533 p. illus. 28 cm.

Autonomous Hydrogen/Air Fuel Cell for Long-Life Missions

Y. Breille, J. Cheron, A. Grehier

Low Cost Air Cathodes, R. N. Camp, B. S. Baker

Thin Carbon Electrodes for Acidic Fuel Cells, K. F. Kordesch, R. F. Scarr

Fuel Cell Battery with Non-Noble Metal Electrodes and Acid Electrolyte

L. Baudendistel, H. Bohm, J. Heffler, G. Louis, F. A. Pohl

Observations on Electrolyte and Product Management for Hydrazine-Oxygen Fuel Cells

Undergoing Changes in Pressure, H. B. Urbach, R. J. Bowen, D. E. Icenhower

Design Parameters of a 300 Watt Ammonia-Air Fuel Cell System

M. F. Collins, R. Michalek, W. Brink

1.5KW Open Cycle Hydrocarbon-Air Fuel Cell, E. A. Gillis

The Phosphoric Acid Fuel Cell, a Long Life Power Source for the Low to Medium
Wattage Range, O. J. Adlhart

A73-15101

International Symposium on Fuel Cells, 4th,
Antwerp, Belgium, October 2, 3, 1972, Proceedings. Volume 1. Mol,
Belgium, Commissariat de l'Energie Atomique, 1972. 308 p. In
English and German.

Topics discussed include the anodic oxidation of methanol; the
reaction mechanism of the hydrazine electrode; the adsorption of
hydrogen by platinum; the influence of structural perturbations on
kinetic processes at platinum and gold electrodes; the effect of
'compensated diffusion' on the potential difference between two
immiscible media; the use of nitrogen containing active carbon as a
cathode catalyst; the use of cobalt phosphide, various organic
compounds, and mixed oxide systems as cathodes or the use of
electronically conducting oxides as cathodes or interconnection
materials. A high-performance air cathode is described, as well as
bipolar noble-metal free and noble-metal containing electrodes, and
some comments are made on Raney, nickel catalysts. Various
applications of hydrogen/air fuel cells are considered.

A.B.K.

Individual items are announced in this issue.

N73-20048# Army Mobility Equipment Research and Develop-
ment Center, Fort Belvoir, Va.

FUEL CELLS Status Report No. 7

James R. Huff, ed. Oct. 1972 182 p refs
(AD-755106; USAMERDC-2039) Avail: NTIS CSCL 10/2

The report describes the present status of fuel cell research.
Since any progress is a result of efforts over a wide range of
research and development, it seemed appropriate to adopt a
format which would reflect this breadth of effort. Therefore, the
first four major sections cover the four categories of government
funding: i.e., basic research, exploratory development, advanced
development and engineering development. Research on power
conditioning, which is a vital part of any fuel cell system is also
discussed. Next the investigation of fuel cell reactions and
mechanisms are reviewed. Finally, fuel cell research and
development is going on in a number of foreign countries, and
thus summaries of their work is given.

GRA

N72-32078# Whittaker Industries, Inc., Wilmington, Mass.
POWER GENERATING SUBCOMPONENT/FUEL CELL
MODULE Final Report, Feb. 1970 - Dec. 1971

R. E. Sebaste and R. J. Dumas May 1972 84 p refs

(Contract DAAB07-70-C-0136)

(AD-744477; ECOM-0136-F) Avail: NTIS CSCL 10/2

A hydrazine air fuel cell power generating module capable
of 120 watts continuous output was designed, constructed,
evaluated. The fuel cell module incorporated design features
permitting low cost manufacturing techniques to be used. This
approach permits the economic use of the desirable characteristics
of a fuel cell power module with the life attainable commensurate
with the present state of the art. A fuel cell module from the
units delivered was selected at random and subjected to an
evaluation test program. The report describes the original design
as represented by the Design Plan, the Final Design incorporated
in the delivered hardware, and the Evaluation Testing. Conducted
to assure compliance with the contract technical requirements.

Author (GRA)

FUEL CELLS: DISPERSED GENERATION OF ELECTRICITY.
T.H. Maugh II.

Science, v.178, Dec.22,1972, p.1273-1274B.

N71-37624# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

PROSPECTS FOR THE APPLICATION OF HIGH TEMPERATURE FUEL CELLS

I. L. Kolbenev et al. 29 Jan. 1971. 11 p. refs. Transl. into ENGLISH from Energomashinost. (Moscow), no. 4, 1970 p. 30-31

(AD-727497; FTD-HT-23-894-70) Avail: NTIS CSCL 10/2.

The work is concerned with prospects for application of high-temperature fuel cells (HTFC) as power sources. Results of analytical research on determination of cell parameters as functions of working process temperature and fuel type are given. Author (GRA)

N72-33088# Institute of Gas Technology, Chicago, Ill.

LOW-COST ACID FUEL CELL STACKS Final Report

Jun. 1972. 108 p. refs

(Contract DAAK02-67-C-0063)

(AD-744806) Avail: NTIS CSCL 10/2

The report concerns research to redesign and to improve compact, low-temperature, acid electrolyte fuel cell stacks. These stacks, which use low-platinum loading electrodes, are operated on air and reformed CITE fuel or combat gasoline. Author (GRA)

N72-14040# Pratt and Whitney Aircraft, East Hartford, Conn.

A 1.5 KW FUEL CELL POWERPLANT Final Report. 1 Jul.

1970 - 30 Jun. 1971

Thomas G. Schiller and Alfred P. Meyer Jun. 1971. 163 p

(Contract DAAK02-70-C-0158; Contract DA

Proj 1-G-663702-DG-1003)

(AD-730796; PWA-4210) Avail: NTIS CSCL 10/2

A 1.5 KW fuel cell powerplant was designed for field power supply. The design was validated by testing a breadboard powerplant incorporating the features of the design. It operates automatically on military logistic fuels over a 0-1.65 KW output power range. The powerplant consists of a dual bed regenerative thermal cracker, an air-cooled phosphoric acid fuel cell subsystem, a solid state voltage regulator, and an automatic control unit. The design is validated by 153 hours of operation of a functionally identical breadboard powerplant. An analysis was conducted to determine the potential of the powerplant.

Author (GRA)

Project Fuel Cell

Issued January, 1971

R&D Report No. 57—Final Report

Contractor: Westinghouse Electric Corporation

Refer to: Titled report and GPO Catalog No. 163.10:57

Price: \$6.75

N73-13056# Army Foreign Science and Technology Center, Charlottesville, Va.

FUEL CELLS AND PROSPECTS FOR THEIR USE IN

RAILROAD TRANSPORTATION

V. M. Anisimov. 13 Jul. 1972. 74 p. refs. Transl. into ENGLISH

of the book "Toplivn. Elementy i Perspekt. Primeneniya ikh na

Zhelezнодорожном Transp." Moscow, Izd. Transp., 1971

(AD-747512; FSTC-HT-23-960-72) Avail: NTIS CSCL 10/2

The principles of the direct conversion of chemical energy into electrical energy are examined. Different types of fuel cells are described and existing power plants and power plants with fuel cells are compared.

TK 2931. V513

A71-11192 Fuel cells: Modern processes for the electrochemical productions of energy. Wolf V. Ielstich (Bonn, Universität, Bonn, West Germany). Research supported by the Arbeitsgemeinschaft für Industrielle Forschung, the Bundesverkehrsministerium, the Deutsche Forschungsgemeinschaft, the Fraunhofer Gesellschaft zur Förderung der Angewandten Forschung, and the Verband der Chemischen Industrie. (Translation of Brennstoffelemente: Moderne Verfahren zur Elektrochemischen Energiegewinnung. Weinheim, West Germany, Verlag Chemie GmbH, 1965.) London and New York, Wiley-Interscience, 1970. 519 p. \$77 refs. \$25.

An attempt is made to present a comprehensive but concise account of research and development in the field of the direct generation of electrical energy by electrochemical processes, to the stage achieved in 1964. The results of extensive hitherto unpublished research are included. In introductory chapters, ideas, terminology, and basic physicochemical principles of electrochemical energy conversion are summarized. Special attention is given to the kinetics of electrode processes from a technological point of view. The recent original work of numerous electrode reactions is reported. The physicochemical and technological problems involved in the construction and operation of complete cells are described. The most promising electrochemical methods for electrochemical conversion of heat and nuclear energy into electrical energy are described. The electrochemical methods for storing electric energy are examined together with the separation of the isotopes of hydrogen accompanying the electrolysis of aqueous solutions. In conclusion, the whole field is briefly reviewed and possibilities of future applications of the new sources of energy are discussed. The book is intended not only for electrochemists but for all groups of research workers interested in energy conversion.

A71-14321 Optimizing hydrazine-oxygen fuel cells. H. Kohl Müller (Siemens AG, Forschungslaboratorien, Erlangen, West Germany). *Energy Conversion*, vol. 10, Nov. 1970, p. 201-205. 5 refs. Research supported by the Bundesministerium der Ver-teidigung.

Consideration of a hydrogen-oxygen fuel cell which has a hydrazine electrode with an active two-phase boundary. This electrode has one or more meshes which are covered with a catalyst which consists of nonnoble metals or their compounds, such as Ni₂B, Co₂B, or Raney nickel either used alone or as a base for other noble metals (Pd-Ru). The cell also has a supported oxygen electrode. The powder catalyst may consist of Raney silver or carbon with silver. The cover layer of this electrode serves simultaneously as the diaphragm. It must consist of electronically nonconductive material; asbestos is mostly used. F.R.L.

TK 2931. F76

A72-33876 From electrocatalysis to fuel cells; Proceedings of the Seminar, Seattle, Wash., December 9-11, 1970. Edited by G. Sandstede (Battelle-Institut, Frankfurt am Main, West Germany). Seattle, University of Washington Press, 1972. 413 p. \$12.50.

The papers deal with research and development work performed for the entire field of fuel cells, with emphasis on the results of research on electrocatalysts. Included are discussions of the state of the art of fuel cell technology for a variety of fuel cell systems. Results obtained for secondary battery systems are used to compare the properties and applications of various energy conversion devices in the light of the last findings, and to discuss in what way and to what extent fuel cells and secondary batteries can supplement each other. Much attention is given to new organic and inorganic electrocatalysts and to electrotraction and implantable fuel cells.

A70-46389 Batteries and fuel cells. M. Barak. *IEE Reviews*, vol. 117, Aug. 1970, p. 1561-1584. 48 refs.

Review of the progress achieved to date in the field of designing portable and transportable power sources. The basic principles of electrochemical power sources are outlined, and the manufacturing processes and performance of the main types are briefly described. Some details are given of new cell types capable of much higher outputs than conventional batteries - in particular, sodium-sulphur, lithium-chlorine, and zinc-air cells. Fuel cells are described in some detail and indications are given of outstanding problems. Finally, the characteristics of the various power sources are summarized, and the relationships between the power and energy densities are illustrated graphically. O.H.

N71-15723# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt. Stuttgart (West Germany). Abt. Magnetofluiddynamische Energiewandlung.

THE FUEL CELL CONCEPT. A REVIEW OF BASIC PRINCIPLES

Richard James Henry Jul 1970 25 p refs (DLR-MITT-70-09) Avail: NTIS; ZLDI Munich; 7.60 DM

The discussion of single cell electrochemistry includes performance characteristics of the Apollo fuel cell using hydrogen-oxygen reactants. Modern applications of cells using oxidant and hydrocarbon fuels are described and the relatively pollutant-free fuel cell exhaust is compared with that from commercial powerplants. Author (ESRO)

1970

N72-33065# Air Force Systems Command. Wright-Patterson AFB, Ohio. Foreign Technology Div.
THE PRESENT AND FUTURE OF FUEL CELLS
 V. S. Begotski and A. M. Skundin 11 Feb. 1972 17 p Transl. into ENGLISH from Khim. v. Shkole (Moscow), v. 25, no. 3, 1970 p 10-16

(AD-743651; FTD-MT-24-1687-71) Avail: NTIS CSCL 10/2
 Electric cells, fuel cells and heat engines are compared. The most common fuel cell using H₂ and O₂ is described in detail. Variations such as plastic-based electrodes, ion-exchange membranes, quasi-solid electrolytes, and high temperature cells are discussed.
 Author (GRA)

A70-30100 * Fuel cells: Their electrochemistry. J. O'M. Bockris (Pennsylvania, University, Philadelphia, Pa.) and S. Srinivasan (New York, State University, Buffalo, N.Y.). Research supported by NASA; Grant No. NSG-325. New York: McGraw-Hill Book Co., 1969. 680 p. 514 refs. \$20.

The text offered attempts to define and explain the basis of the functioning of fuel cells and the reactions at the electrodes, as well as to provide a basis for the direction of future research. Knowledge of other basic disciplines, in particular hydrodynamics and materials science, is also necessary for the worker concerned with fuel cells. The writing of this book was influenced by the absence of education in electrochemistry in high schools and universities. Direct energy conversion methods and the advantages of the electrochemical method are first discussed, followed by study of basic electrode kinetics. Thermodynamic aspects of electrochemical energy conversion are considered, and some electrode kinetic aspects of electrochemical energy conversion are examined. The kinetics of electrode reactions in porous media are treated, followed by an extensive study of electrocatalysis. Attention is given to electrochemical combustion of organic substances and to electrochemical reactions of oxygen. Fuel-cell research techniques are outlined, and types of fuel cells are described.
 F.R.L.

TK2931.E7

Breiter, Manfred W 1925-
Electrochemical processes in fuel cells (by, Manfred W. Breiter. (New York, Springer-Verlag New York, 1969.
 xi, 274 p. illus. 25 cm. (Anorganische und allgemeine Chemie in Einzeldarstellungen, Bd. 9) 12.00

Includes bibliographies.

1969

FUELS FOR FUEL CELLS. F. Jones.
 Fuel, v. XLVIII, no.1, Jan.1969, p.47-60.

Paper reviews the extent to which fuels other than hydrogen have found use in fuel cells and examines the problems to be overcome before any of them is likely to achieve commercial acceptance.

TK2931.B46

Berger, Carl, ed.
Handbook of fuel cell technology.
 Englewood Cliffs, N. J., Prentice-Hall, c.1968,
 607 p.

TK2931.L53

Liebhafsky, H A
 Fuel cells and fuel batteries; a guide to their research and development (by, H. A. Liebhafsky and, E. J. Cairns. New York, Wiley, 1968,
 x, 692 p. illus. 23 cm.
 SBN 471-53450-X
 Includes bibliographical references.

681

TK
2896
.I 55
1969

Intersociety Energy Conversion Conference, 4th,
Washington, D. C., 1969.
Proceedings. [New York, American Institute of
Chemical Engineers, 1969]

xxxiii. 1080 p. illus. 28 cm.

Held at Washington, D. C., September 22-26,
1969.

Sponsored by American Institute of Chemical
Engineers, American Society of Mechanical Eng-
ineers, American Institute of Aeronautics and
Astronautics, American Nuclear Society,

**Economic High-Pressure Hydrogen-Oxygen Regen-
erative Fuel-Cell Systems**

Page 1042

699129

H. J. ALLISON, R. RAMAKUMAR AND W. L. HUGHES.
OKLAHOMA STATE UNIVERSITY, STILLWATER, OKLA-
HOMA

Ammonia-Air Fuel Cell System

Page 1048

699130

P. L. TERRY (SPEAKER) AND O. J. ADLHART, ENGLE-
HARD INDUSTRIES, NEWARK, NEW JERSEY

**The Hydrazine-Air Bi Cell, A Simplified Fuel Cell
System**

Page 1052

699131

J. PERRY, JR. AND L. J. ROGERS, U.S. ARMY ELEC-
TRONICS COMMAND, FORT MONMOUTH, NEW JERSEY

**A Circulating Electrolyte Hydrogen/Air Fuel Cell
System**

Page 1057

699132

C. G. CLOW AND J. G. BANNOCHIE, ENERGY CON-
VERSION LIMITED, BASINGSTOKE, ENGLAND

High Power Density Fuel Cell

Page 1065

699133

B. DURANTE (SPEAKER), U.S. AIR FORCE, WRIGHT-
PATTERSON AIR FORCE BASE, OHIO, J. K. STEDMAN
AND C. L. BUSHNELL, PRATT & WHITNEY AIRCRAFT,
SOUTH WINDSOR, CONNECTICUT

THE FUEL CELL PROBLEM.

Ernst M. Cohn (NASA, Washington, D.C.).

Institute of Electrical and Electronics Engineers, International Convention and Exhibition, New York, N.Y., Mar. 18-21, 1968.

Paper. 4 p.

Discussion of the historical background, development, and operation of fuel cells, with special attention devoted to the materials, applications, and engineering problems of fuel cells using hydrogen and oxygen (pure or as air). These problems involve the minimization of the amounts of precious platinum and palladium catalysts, the optimization of electrodes and cell structures, and the problem of high cost per kilowatt.

V. Z.

PROJECT FUEL CELL.

Harris F. White, senior member, IEEE

IEEE Trans, Power Apparatus and Systems, v. PAS-87, no. 11, Nov. 1968, p. 1956-1960.

Reviews the status of high-efficiency, coal-oxidation, solid-electrolyte fuel cells being developed under Project Fuel Cell. Describes the manufacturing technique of thin film batteries consisting of numerous fuel cells and a 100-kW power plant now under construction, and projects the economies of a 1000-MW fuel-cell power plant.

A68-41848

FUEL CELLS - THEIR STATUS AND FUTURE OUTLOOK.

E. Yeager (Case-Western-Reserve University, Dept. of Chemistry, Cleveland, Ohio).

Chemical Engineering Progress, vol. 64, Sept. 1968, p. 92-96.
42 refs.

Examination of the state of the art and future potential of fuel cells such as hydrogen-oxygen cells, hydrazine-oxygen cells, hydrocarbon-consuming cells, and sodium amalgam-oxygen cells. An H₂-O₂ type (by GE) has been used as nonpropulsive power source for orbital missions in the Gemini project; another (by Pratt and Whitney) will be applied in the Apollo project; and a third (by Allis Chalmers) is under study for later space projects. Voltage output under operating conditions is about 0.9 V for the hydrogen-oxygen type. Problems that remain to be overcome in all types are low power densities and short operating life. Some materials problems arise from the high operating temperatures required in the case of the hydrocarbon-consuming cell. In regions with high cost of electrical power the further development of the sodium amalgam-oxygen cell might be attractive.

R. M.

A70-27757

Fuel cell systems - II; American Chemical Society, Meeting, 154th, Biennial Fuel Cell Symposium, 5th, Chicago, Ill., September 12-14, 1967, Proceedings. Washington, D.C., American Chemical Society (Advances in Chemistry Series, No. 90), 1969, 454 p. \$17.50.

Contents:

Preface, B. S. Baker, p. ix.

Pulsed power fuel cells, R. A. Sanderson, C. L. Bushnell, and T. F. McKiernan (United Aircraft Corp., East Hartford, Conn.), p. 60-69. (See A70-27758 12-03)

The operation mechanism of a porous hydrogen electrode with a nickel catalyst, R. Ch. Burshtein, A. G. Pshenichnikov, and F. Z. Sabirov (Akademiia Nauk SSSR, Institut Elektrokhimii, Moscow, USSR), p. 70-80, 11 refs. (See A70-27759 12-06)

Oxygen reduction on gold alloys in alkaline electrolyte, J. Giner, J. M. Parry, and L. Swette (Tyco Laboratories, Inc., Waltham, Mass.), p. 102-113. (See A70-27760 12-06)

The adsorption of carbon monoxide on platinum and rhodium electrodes, S. Gilman (NASA, Electronics Research Center, Cambridge, Mass.), p. 114-127, 20 refs. (See A70-27761 12-06)

Electrochemical oxidation of multicomponent hydrocarbon fuels. III - Relative reactivities in the electrochemical oxidation of hydrocarbon fuel components, E. Luksha and E. Y. Weisman (General Electric Co., West Lynn, Mass.), p. 200-222, 5 refs. (See A70-27762 12-06)

Electrolyte studies for molten carbonate fuel cells. I. Trachtenberg and D. F. Cole (Texas Instruments, Inc., Dallas, Tex.), p. 269-280, 17 refs. (See A70-27763 12-03)

A liquid hydrocarbon fuel cell battery, E. H. Okrent and C. E. Heath (ESSO Research and Engineering Co., Linden, N.J.), p. 328-340. (See A70-27764 12-03)

Recent advances in fuel cells and their application to new hybrid systems, E. J. Cairns and H. Shimotake (Argonne National Laboratory, Argonne, Ill.), p. 392-425, 85 refs. (See A70-27765 12-03)

Low-temperature natural gas fuel cell battery, W. J. Conner, B. J. Greenough, and G. B. Adams (Lockheed Materials Sciences Laboratory, Palo Alto, Calif.), p. 426-440. (See A70-27766 12-03)
Index, p. 441-448.

A67-40137*# Thompson (John I.) and Co., Inc., Washington, D. C.
FUEL CELLS—A REVIEW OF GOVERNMENT-SPONSORED RESEARCH, 1950-1964

L. G. Austin (North Carolina State Univ.) 1967 451 p refs
(Contract NASW-1039)
(NASA-SP-120) CFSTI: HC \$3.00/MF \$0.65 C3CL 10A

A comprehensive review of fuel cell research and technology is presented. The review covers the principles, types, and uses of fuel cells; fuel cell electrodes, electrolytes, and matrices; low temperature, medium temperature, and high temperature fuel cell and stack construction; sodium amalgam-oxygen cell and stack construction; fuel cell systems and control; electrolytically regenerative hydrox fuel cells; thermally regenerative fuel cells; thermogalvanic cells; photochemically regenerative and redox cells; hybrid fuel cells; biochemical fuel cells; direct hydrocarbon fuel cells; miscellaneous fuels and oxidants; kinetics of hydrox fuel cell reactions; and theories of porous electrodes.

R.N.A.

684

TK Hart, Anthony Bernard

2931 Fuel cells: theory and application [by] A.B.
.H36 Hart and G.J. Womack. London, Chapman & Hall,
1967.

xii, 372 p. illus. 19 cm.

~~TK2931.W5~~
WILLIAMS, K. R., ED.

An introduction to fuel cells.
Amsterdam, Elsevier, 1966. TK2931.W5
xiv, 329 p.

Review and Evaluation of Project Fuel Cell

Issued February, 1967

R&D Report No. 17—Final Report

Contractor: Jackson & Moreland Division of United
Engineers & Constructors, Inc.

Refer to: Titled report and PB-173765

Price: \$6.00 NTIS

TK2931.B3 1965

BAKER, B. S., ED.

Hydrocarbon fuel cell technology; a
symposium. New York, Academic, 1965.
xiv, 560 p. TK2931.B3 1965

TK2896.I5 1965c

Engineering Developments in Energy Conversion.

(Presented at Internat. Conf. on Energetics, Rochester Univ.,

FUEL CELLS FOR POWER GENERATION Aug. 18-20, 1965, Amer. Soc. Mech. Eng.)

The Growth of Fuel Cell Systems by Ernst M. Cohn 252

Prospectus for Hydrocarbon Fuel Cell Power Plants by
Galen R. Frysinger 266

The Methanol Fuel Cell Battery by Barry L. Tarmy and
George Ciprios 272

Operating Characteristics of an Economical High Temperature
Fuel Cell by S. S. Baker and L. G. Marianowski 284

The Electrochemical Engine by R. E. Hendryson, B. Agruss, and
D. A. J. Swinkels 293

Heat and Mass Transfer Characteristics in Ion Exchange
Membrane Fuel Cells by Jacob G. Bortas 309

HOW FORD EVALUATES THREE TYPES OF ELECTRIC VEHICLES.

L.W. Unnewehr, et al.

Automotive Engineering, v.82, no.6,
June 1974, p.37-41,75,77.

Here are results of in-depth feasibility studies on a small, minimum performance city car, a higher-performing metropolitan car, and a delivery van/city bus with electric drive. Also included is a state-of-the-art look at storage batteries, and future drivetrain, braking, steering needs.

SWITCHING ON ELECTRIC VEHICLES.

Environmental Sci. & Engineering, v.8, no.5,
May 1974, p.410-411.

Speakers and exhibitors at the recent "Third International Electric Vehicle Symposium and Exposition" (Washington, D.C.) extensively discussed the makeup of the electric vehicles.

THE ELECTRIC CAR: WILL IT REALLY GO?

T.J. Healy.

IEEE Spectrum, v.11, no.4, Apr.1974, p.50-53.

It may not save energy, but it could be cheaper, less polluting, and in the long haul, petroleum conserving.

THE NEED FOR DEVELOPMENT OF HIGH-ENERGY BATTERIES FOR ELECTRIC AUTOMOBILES.

P.A. Nelson, et al

Argonne Nat. Lab., ANL-8075, Jan.1974.

(CONF-740215-1) ANL HIGH-ENERGY BATTERIES FOR ELECTRIC VEHICLES. Nelson, P. A.; Chlenskias, A. A.; Walsh, W. J.; Gay, E. C. (Argonne National Lab., Ill. (USA)). 1974. 18p. Dep. NTIS \$3.00.

From 3rd international electric vehicle symposium; Washington, District of Columbia, USA (19 Feb 1974).

A program at ANL to develop batteries for use in electric automobiles and in electric utilities is described. Discussions and data are included on the need for electric cars, battery performance objectives, battery design, experimental results, and plans for transfer of battery technology to industry. (JRD)

Lithium - Inorganic Electrolyte Batteries.

David R. Cogley, and Michael J. Turchan.

Eic Inc Newton Mass Feb 74. 41p C-401, ECOM-0030-1-74
AD-775 420/3WE PC\$3.25/MF\$1.45

The purpose of the present program is to study the feasibility of an all-inorganic electrolyte lithium primary battery operable and storable over the temperature range of -40F to +160F. The desired energy density is 150 watt-hours per pound of total battery weight and the desired power density is 50 watts per pound.

N74-14792# Defense Documentation Center, Alexandria Va.
BATTERIES Report Bibliography. Jan. 1967 - Apr. 1973
Oct. 1973 356 p refs

(AD-768500: DDC-TAS-73-59) Avail: NTIS CSCL 10/3

The bibliography is a selection of unclassified and unlimited citations on batteries. These references present information on design, cells, test, development, components, and performance characteristics. Discussed are many types of batteries, with most references relating to the nickel cadmium batteries and organic batteries.

GRA

S-446

SUPERBATTERIES.

J.R. Free.

Popular Science, Oct. 1973, p.100-103, 148.

They'll store electric power using molten salts hotter than your oven. And they pack the wallop need for electric vehicles.

N73-30068# Argonne National Lab., Ill.
LITHIUM/SULFUR BATTERIES FOR OFF-PEAK ENERGY STORAGE: A PRELIMINARY COMPARISON OF ENERGY STORAGE AND PEAK POWER GENERATION SYSTEMS
M. L. Kyle, E. J. Cairns, and D. S. Webster Mar. 1973 116 p refs

(Contract W-31-109-eng-38)

(ANL-7958) Avail: NTIS HC \$5.45

The use of lithium/sulfur batteries as load-leveling devices in electrical utility networks could provide both economic and ecological benefits in meeting the growing demand for energy. A battery designed for this application should have an initial capital cost of \$12 to \$15/kW-hr of energy storage capacity and a lifetime of at least five years. A typical duty cycle is expected to be a 10 to 14 hr discharge followed by a 4 to 8 hr charge with the battery operating about 5 days per week. Economic and cell performance goals for the development of a battery system are presented. A preliminary comparison of the costs of batteries, pumped hydroelectric storage and gas turbines indicates that, under some conditions, batteries should be considered as load-leveling devices. The lithium/sulfur battery system is in too early a state of development to accurately predict its place in the utility system.

Author (NSA)

TK

2996

.155

1973

Intersociety Energy Conversion Engineering Conference, 8th Philadelphia, Pa., 1973.

Proceedings. New York, American Institute of Aeronautics and Astronautics [1973]

847 p. illus. 29 cm.

Held at: University of Pennsylvania, Philadelphia, Pa., August 13-16, 1973.

Sponsored by: American Institute of Aeronautics and Astronautics [and others]

Stable, High Energy Non-Aqueous Electrolyte Lithium Batteries - M. EISENBERG, K. WONG.....P.5A.....

The Development of Lithium/Sulfur Cells for Application to Electric Automobiles - E. C. GAY, R. K. STEUNENBERG, J. E. BATTLES, E. J. CAIRNS.....P.5B.....

1973

A73-38403 # High energy density silver-hydrogen cells for space and terrestrial applications. R. J. Haas and D. C. Briggs (Philco-Ford Corp., Palo Alto, Calif.). In: Intersociety Energy Conversion Engineering Conference, 8th, Philadelphia, Pa., August 13-16, 1973, Proceedings. (A73-38386 19-03) New York, American Institute of Aeronautics and Astronautics, Inc., 1973, p. 116-120.

Description of the performance and design characteristics of recently developed silver-hydrogen cells. The first phase of this program encompassed design and electrical cycling of single and multiple plate cells. Based on the high rate (2C) long cycle life performance demonstrated by these cells, a series of production type 4.0 and 20.0 ampere-hour cells were designed, constructed, and electrically characterized. The basic cell design consists of rectangular silver and catalyzed fuel cell plates alternately stacked in a hermetically sealed prismatic container. Electrical connection is provided by ceramic-metal seals. Heat is dissipated from the cell core through the flat container surfaces to intercostal thermal shunts, minimizing temperature gradients within the cell. In general, the performance indicates that this design is capable of producing energy densities in excess of 60 watt hours per pound. (Author)

N74-22709# Techtran Corp., Glen Burnie, Md.

MEETING FUTURE PEAK ELECTRICAL ENERGY DEMANDS BY MEANS OF ELECTROCHEMICAL STORAGE SYSTEMS

Klaus D. Beccu Washington NASA May 1974 12 p refs
Transl. into ENGLISH from Chem.-Ingr.-Tech., v. 46, no. 3, 1974 p 95-99 Presented at the Session of GDCh Specialist Group Appl. Electrochem., Ludwigshafen am Rhein, West Germany, 4-5 Oct. 1973
(Contract NASw-2485)

(NASA-TT-F-15634) Avail: NTIS HC \$4.00 CSCL 10C

The electrical energy crisis is considered in terms of storage equipment. Various types are compared in terms of costs, efficiency, maintenance, and raw material reserves. It is concluded that more study and research is needed before adequate energy storage systems can cover peak load periods. Author

1973

ED Institute of Electrical and Electronics Engi-
9540.4 neers International Convention and Exposition.
15 1973.

1973 Prospecting for energy: 1973 IEEE Intercon
technical papers. [New York, Institute of
Electrical and Electronics Engineers, 1973]
1 v. (various pagings) illus. 28 cm.

Prospects for Applying Electrochemical Energy Storage in Future Electric Power Systems.

P. A. Lewis and J. Zemkoski, Public Service Electric and Gas Co., Newark, N. J.

P. 13/2-

Electric power system load characteristics and capacity requirements are described. The merits of dispersed electrochemical energy storage generation devices are discussed. Optimum sizes, amounts, and points of installation are described and savings associated with the installation of such storage devices are estimated. The characteristics of existing types of batteries and those currently under development are reviewed.

N74-18737# Energy Research Corp., Bethel, Conn.
HIGH ENERGY SEALED NICKEL-ZINC BATTERIES Final
Annual Report, 1 Mar. 1972 - 1 Oct. 1973

Allen Charkey Nov. 1973 44 p
(Contract DAAB07-72-C-0114; DA Proj. 1T7-62705-A-053)
(AD-772944; ECOM-0114-F) Avail: NTIS CSCL 10/3

A sealed 7 Ah/6.5 volt nickel-zinc battery has been developed which is capable of 160-200 cycles of operation at approximately 60% depth of discharge at the C/4 rate. Initial energy density obtained was 28 Wh/lb at the C/4 discharge rate. The battery will deliver about 40% of its energy at -20F at the C/4 rate. With silver amalgam oxygen recombination electrodes the battery is capable of continuous overcharge at 0.5 amperes at a safe steady state pressure below 50 psi. Improved inorganic separators (ERC-2002) have been developed which are chemically inert in KOH, have a uniform pore size distribution and stop the occurrence of zinc dendrites. The primary cause of failure of the battery was found to be from the zinc electrode failure. (Modified author abstract) GRA

TITLE: Pollution-Free Electrochemical Power

Generation from Low Grade Coal

AUTHOR: McMillen, D.F.; Weaver, B.D.; Ambar, B.

CORPORATE AUTHOR: Stanford Research Institute

ADDRESS: Menlo Park, CA 94025

PUBLICATION DESCRIPTION: Interim report, 42 P.,

15 references

PUBLICATION DATE: 1973, August

SPONSOR: National Science Foundation, MAN Program

ABSTRACT: This report describes the results of a

study, sponsored by NSF, exploring the

feasibility of a nonpolluting, combined

chemical-electrochemical system for

generating electrical power. The process

entails the use of coal to reduce lead oxide

to a lead in a molten carbonate medium. The

lead contained in the molten carbonate is

then used in a metal-air electrochemical cell

to generate electrical

power.---Extrapolation of---results

indicates that the feasibility of the concept

will not be limited by the rate of PbO

reduction. It also indicates that the system

would be capable of producing electrical

power from coal at 3.4 mil/kWh on the basis

of a fuel cost of \$10 per ton; i.e., with an

overall efficiency of 42%. Since the melt

retains hydrogen sulfide and sulfur oxides,

the process could operate equally well as

high-sulfur coal char, at an even lower fuel

cost per kilowatt-hour. (Auth, Abstract

modified)

N74-16765# Oklahoma Univ., Norman.

WIND POWER DEMONSTRATION AND SITING PROB-

LEMS

Karl H. Bergoy In NASA. Lewis Res. Center Wind Energy

Conversion Systems Dec. 1973 p 41-45 refs (For availability

see N74-16757 08-03)

CSCL 10B

Technical and economic feasibility studies on a small

windmill to provide overnight charging for an electrically driven

car are reported. The auxiliary generator provides power for heating

and cooling the vehicle which runs for 25 miles on battery

power alone, and for 50 miles with the onboard charger operating.

The blades for this windmill have a diameter of 12 feet and are

coupled through to a conventional automobile alternator so that

they are able to completely recharge car batteries in 8 hours.

Optimization of a windmill/storage system requires detailed wind

velocity information which permits rational siting of wind power

system stations. G.G.

High-Performance Batteries for Off-Peak Energy Storage.

P. A. Nelson, W. J. Walsh, R. K. Steubenberg, J. E. Battles, and M. L. Kyle.

Argonne National Lab., Ill. Mar 74, 67p
ANL-8038 PC\$5.45/MF\$1.45

The report is the first in a series of semiannual reports on a program to develop high-specific-energy lithium/sulfur batteries for off-peak energy storage in electric utility networks. The design goals for the battery include a specific energy of 150-200 W-hr/kg, a specific power of 25-50 W/kg, and a lifetime of 5 years and more than 1250 charge-discharge cycles. Initial cell tests have been directed toward development of (1) a Li-Al alloy electrode, formed by electrochemical deposition of lithium on a porous substrate of aluminum fibers and (2) a sulfur electrode consisting of a mixture of a sulfur-ar-senic alloy and finely divided carbon. The cell development effort is supported by Laboratory studies, in which problems associated with cell reactions are investigated, and by materials studies, in which cell components are fabricated and new materials of construction are identified and tested to determine their corrosion resistance to the cell environment. (Modified author abstract)

Low Power Methanol-Air Battery.

John Perry, Jr.

Army Electronics Command Fort Monmouth N J Apr 74,

24p ECOM-4213

AD-779 183/3WE PC\$3.00/MF\$1.45

An increased need for low power, long life power supplies has become apparent with the development of transistorized military communications and surveillance equipments. In view of this, a set of test specifications approximating characteristic performance requirements was defined in order to establish the feasibility criteria for a low power methanol-air-battery. An energy density of 88 Wh/lb was set as a goal, at a continuous drain of 45 mW for 2,000 hours, with the capability of response to 15 W pulses for 6 seconds at 10-minute intervals. A 9-cell battery stack was fabricated in-house for test and evaluation under the 45 mW/15 W load profile. The teflon-bonded anode was catalyzed with 75% Palladium/25% Platinum and the cathodes catalyzed with silver. The total

BATTERIES: The first volume in a survey series on various types of batteries, beginning with manganese dioxide batteries. Alkaline cells are also treated. The series is directed at electrical and electronics engineers, physical chemists, and other scientists and engineers working with battery power systems. 592 pages. (ISBN: 0-8247-6084-0, available at \$47.50 from Marcel Dekker, Inc., 305 E. 45th St., New York, N.Y. 10017.)

A CAR TO BEAT THE FUEL CRISIS?

N. Valery.

New Scientist, Dec.20,1973, p.840-842.

The electric car is just about feasible using present-day technology. The electric commuter vehicle needs at least a further five years of development.

N74-10946 # National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
ELECTRIC VEHICLE BATTERY RESEARCH AND DEVELOPMENT

Harvey J. Schwartz 1973 18 p refs Presented at the Electrochem. Soc. Meeting, Boston, 7-11 Oct. 1973. (NASA-TM-X-71471; E-7772) Avail: NTIS HC \$3.00 CSCL 10C

High energy battery technology for electric vehicles is reviewed. The state-of-the-art in conventional batteries, metal-gas batteries, alkali-metal high temperature batteries, and organic electrolyte batteries is reported. G.G.

(ANL-8039) DEVELOPMENT OF HIGH-SPECIFIC-ENERGY BATTERIES FOR ELECTRIC VEHICLES. Progress Report, February 1973-July 1973. Nelson, P. A.; Gay, E. C.; Steenberg, R. K.; Batties, J. E.; Schertz, W. W.; Vlasers, D. R.; Myles, K. M.; Kyle, M. L.; Webster, D. S.; Burris, L. (Argonne National Lab., Ill. (USA)). Dec 1973. Contract W-7405-109-eng-38. 47p. Dep. NTIS \$5.45.

A high-specific-energy lithium/sulfur battery having the performance characteristics required for powering pollution-free automobiles is described. The cells currently under development have negative electrodes of molten lithium and positive electrodes of sulfur (plus an additive to reduce the sulfur vapor pressure) separated by a molten lithium halide-containing electrolyte. The operating temperature of the cells is about 400°C. The performance goals for a single cell include a capacity density of 0.4 A-hr/cm² at a current density of 0.1 A/cm², a peak power density of 1-2 W/cm², and a minimum cycle life of 1000 cycles. Cells with positive electrodes consisting of sulfur-arsenic-carbon mixtures in graphite housings have achieved short-time peak power densities and capacity densities that meet or exceed the goals for a single cell. A capacity density of 0.1 A-hr/cm² has been sustained at a discharge current density of 0.1 A/cm² (1-V cutoff) for more than 500 hr and 100 cycles. Improvement in cell design is needed, however, to achieve higher sulfur utilization and longer cell lifetimes. (auth)

N74-20708# TRW Systems Group, Redondo Beach, Calif.
INVESTIGATION OF HIGH TEMPERATURE BATTERY SYSTEMS Final Technical Report. 1 Jul. 1972. 31 Oct. 1973

E. I. Seo, R. R. Savano, D. F. Carroll, M. L. McLanahan, and H. P. Silverman. Jan. 1974. 46 p.
(Contract DAAB07-72-C-0312)
(AD-774308; TRW-23323-6015-RU-00; ECOM-0312-F) Avail: NTIS CSCL 10/3

The main objective of this program was the construction and testing of sodium-sulfur cells which would be hermetically sealed and operable at 300°C. Intermediate objectives included the evaluation of all proposed materials, seals and construction techniques as to their suitability for the sodium-sulfur system. New sealing methods for making ceramic to metal seals were developed. (Modified author abstract) GRA

Theoretical Simulation of the Performance of Molten Salt Thermal Batteries.

Alan S. Kushner.
Naval Ordnance Lab White Oak Md Aug 73, 29p NOLTR-74-24
AD-779 269/OWE PCS3.25/MF\$1.45

A computer program for the Thermal and Electrical Analysis of Batteries (TEAB) has been developed as a tool for the computer-aided design of molten salt thermal batteries. TEAB solves the coupled set of equations describing the temperature distribution within a molten salt cell and the electrical characteristics of the cell. Heat generation due to start-up heat source, electrochemical phenomena, and the flow of electric current within the cell are all included. The program calculates the spatial and time temperature variation within the cell during start-up and during cell operation, checks for a satisfactory molten electrolyte zone for cell operation, and calculates the cell voltage-current characteristics as a function of time. TEAB has been utilized in the Li-Cl2 Battery Development Program at the Naval Ordnance Laboratory. (Modified author abstract)

(CONF-730648-1) ELECTRIC CAR. Nelson, P. A.
(Argonne National Lab., Ill. (USA)). 1973. 10p. Dep. NTIS \$3.00.

From International symposium and workshop in the hydrogen economy; Ithaca, New York, USA (19 Aug 1973).

If a suitable battery can be developed, the electric automobile would definitely have a place in the transportation field. It is believed that a suitable battery can be developed because of the recent successes at ANL and elsewhere and because better cell systems may result from basic electrochemical studies. The manufacture of electric cars to the extent of 1 to 2% of the total automobile production in 1985 is a reasonable prospect. (auth)

1973

A74-14248 Chemical storage of hydrogen in Ni/H₂ cells. M. W. Earl and J. D. Dunlop (COMSAT Laboratories, Clarksburg, Md.). COMSAT Technical Review, vol. 3, Fall 1973, p. 437-441. 5 refs. Research sponsored by the International Telecommunications Satellite Organization.

It is shown that LaNi₅ hydride can be used to reduce the operating pressure of a nickel/hydrogen cell without affecting its high cycle-life expectancy. Advantages of this concept are: safe operation at high hydrogen pressures, cell volume reduction of almost 50%, and simplification of cell pressure vessel design through prismatic-type cell construction; this eliminates electrolyte loss problems, provides an electrode stack design with improved shock and vibration characteristics, and simplifies battery packaging. V. P.

N74-16784* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

BATTERIES FOR STORAGE OF WIND-GENERATED ENERGY

Harvey J. Schwartz. In *its* Wind Energy Conversion Systems Dec. 1973 p 146-151 (For availability see N74-16757 08-03) CSCL 10C

Cost effectiveness characteristics of conventional-, metal gas-, and high energy alkali metal-batteries for wind generated energy storage are considered. A lead-acid battery with a power density of 20 to 30 watt/hours per pound is good for about 1500 charge-discharge cycles at a cost of about \$80 per kilowatt hour. A zinc-chlorine battery that stores chlorine as solid chlorine hydrate at temperatures below 10 C eliminates the need to handle gaseous chlorine; its raw material cost are low and inexpensive carbon can be used for the chlorine electrode. This system has the best chance to replace lead-acid. Exotic alkali metal batteries are deemed too costly at the present stage of development.

TRANSPORTATION: The Electric Car - fact or fancy?
Can we meet the demand for energy by electric cars? And will our air be any cleaner with the widespread use of electrics?

By Jalal T. Salihi.

IEEE Spectrum, June 1972, 44-48. 11 refs.

1972

N73-19061# Argonne National Lab., Ill.
DEVELOPMENT OF HIGH-SPECIFIC-ENERGY BATTERIES FOR ELECTRIC VEHICLES Progress Report, Feb. - Jul. 1972
E. J. Cairns, E. C. Gay, R. K. Steunenberg, H. Shimotake, J. R. Selman, T. L. Wilson, and D. S. Webster Sep. 1972 114 p refs

(Contract W-31-109-eng-38)

(ANL-7953) Avail: NTIS

The technology required to construct secondary batteries having the performance capabilities required for pollution free electric automobiles is discussed. Batteries for this application should have an energy storage capability of 220 W/kg. Their cost should not exceed about \$10/KW-hr of energy storage capability. Lithium/sulfur cells using a molten lithium halide-containing electrolyte and operating at 360 to 390 C have achieved capacity densities of up to 0.9 A-hr/sq cm (above 1 V) at a current density of 0.9 A/sq cm with a cycle life of more than 2000 cycles during 7000 hr of operation. The enclosed mixed-cathode Cell L-9 had a cycle life and lifetime of 150 cycles and 1000 hr, respectively, with a capacity density up to 0.4 A-hr/sq cm at a current density of 0.24 A/sq cm to a 1.0-V cutoff. These results are consistent with the specific energy and specific power goals, but the cycle life and the sulfur electrode performance require further improvement. Author

1972

N73-21986# TRW Systems Group, Redondo Beach, Calif.
DEVELOP HIGH CHARGE AND DISCHARGE RATE LEAD/ACID BATTERY TECHNOLOGY Final Report, 28 Apr. 1971 - 18 Mar. 1972

H. P. Silverman Apr. 1972 170 p refs

(Contract EPA-68-04-0028)

(PB-213257; TRW-18353-6006-RO-00; APTD-1345) Avail:

NTIS CSCL 10C

The objective of the program was to develop a high charge rate, high discharge rate lead-acid battery compatible with the requirements of a hybrid heat-engine/electric vehicle. Because the power requirements and charge-discharge profiles for a hybrid-vehicle battery are sufficiently different than those for a conventional lead-acid battery, a development program was undertaken to optimize the lead-acid battery for hybrid-vehicle use. As a result of this program, ten test cells producing specific powers of 150 W/lb for a 75-sec discharge and 204 W/lb for a 20-sec discharge were developed and tested. The achievements under the program included: fabrication of thin, conductive vitreous carbon-epoxy substrates, chemically inert to lead-acid cell environment; a method for applying (pasting) the active material onto the substrate; and negative bipolar plates that exceeded the performance target of 2A/sq in 10.3 A/sq cm) at 1.5V for 60 sec and out performed standard pasted plates.

TK Intersociety Energy Conversion Engineering
2896 Conference, 7th, San Diego, Calif., 1972.
I 55 Proceedings. Washington, D. C., American
1972 Chemical Society, 1972.
1533 p. illus. 28 cm.

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G. H. Gelb, B. Berman, R. S. Lipkus, T. C. Wang	
Dual Turbine-Battery Electric Vehicle Drive System, C. J. Heise	P. 1103-

1972

N73-14067# Tyco Labs, Inc., Waltham, Mass.
LITHIUM-NICKEL SULFIDE BATTERIES Final Report, 1 Apr.
1971 - 31 Mar. 1972
Lewis Gaines and Raymond Jasinski Jul. 1972 53 p
(Contract F19628-71-C-0153; AF Proj. 8659)
(AD-749861; C-929; AFRL-72-0418) Avail: NTIS CSCL
10/3

The work described represents a development program designed to improve the performance of the lithium-nickel sulfide battery system at high rates and/or at low temperatures. Investigation of the high rate discharge performance of Ni3S2 indicated that rate capability was strongly influenced by the viscosity of the cell electrolyte. Stable discharges at up to 6 mA/sq cm were obtained from Teflon-bonded electrodes in a tetrahydrofuran/LiClO4 electrolyte. Study of the Ni3S2 oxidation procedure indicated that the optimum temperature for the production of the high voltage material was 325°C. X-ray diffraction analysis of the oxidized Ni3S2 indicated the presence of the relatively sulfur rich nickel sulfides: Ni7S6 and NiS(1.09). These materials possess higher theoretical energy densities than Ni3S2. A brief study of the discharge properties of metallic oxides, carbonates, and cyanides in propylene carbonate/LiClO4 electrolyte indicated that although several of these materials exhibited acceptable discharge and voltage efficiencies, none were of sufficient interest to justify further development. GRA

THE SOLAR ERA: PART 4 - THE UNIVERSITY OF FLORIDA "ELECTRIC".

H.R.A. Schaeper and E.A. Farber.
Mechanical Engineering, Nov. 1972, p.20-24.

The "electronics" are coming, or will be, if the I-C engine finds the price of its fabulous success—cleaning up its massive pollution of the ambient air—too steep. Now undergoing a feverish rash of development, the electronics will then get a second change. Here's a report on a GM Corvair converted into a test bed for battery-electric propulsion.

TK Smith, George, 1911-
2941 Storage batteries, including operation,
.S57 charging, maintenance and repair [by] G.
1971 Smith. London, Pitman [1971]
xiii, 231 p. illus. 23 cm.

N72-32076# Atomic Energy Centre, Lahore (Pakistan).
RECHARGABLE BATTERIES: A SELECT BIBLIOGRAPHY
M. Saleem Oct. 1971 318 p refs
(AECL-PAK/Lib-34) Avail: AEC Depository Libraries
published between 1954 and 1970 on rechargeable batteries for use in aerospace technology. The abstracts are arranged in chronological order by publication date within each of the following categories: nickel-cadmium batteries, silver-cadmium batteries, silver-zinc batteries, alkaline batteries, storage batteries, and electrodes. An author index is included. NSA

Hamlen, R. D., and Christopher, H. A.,
"Battery Power and Energy Density
Requirements for Vehicle Propulsion",
General Electric Co. Rpt. No. 71-C-306.

Herbert, G. F., and Anderson, A. E.,
"Power Requirements of Electric
Vehicles", SAE Paper 710238, January,
1971

N72-21039# Argonne National Lab., Ill. Chemical Engineering
Div.
DEVELOPMENT OF HIGH-ENERGY BATTERIES FOR
ELECTRIC VEHICLES Progress Report, Jul. 1970 - Jun.
1971

E. J. Cairns, R. K. Steunenberg, J. P. Ackerman, B. A. Feay, D.
M. Gruen, M. L. Kyle, T. W. Latimer, J. N. Mundy, R. Rubischko,
H. Shimotake et al Jul. 1971 98 p refs Sponsored by AEC
(PB-205254; APTD-0875) Avail: NTIS CSCL 10C

The objective is to develop the technology required to construct secondary batteries having the performance capabilities required for pollution-free electric automobiles. Lithium/sulfur cells using a molten lithium halide-containing electrolyte and operating at 360 to 390 °C have achieved capacity densities of up to 0.52 A-hr/sq cm (above 1 V) at a current density of 0.52 A/sq cm. The solubility of cathode materials in various electrolytes and the identity of the soluble species are studied. Preliminary results indicate that electrolytes containing only fluoride and chloride anions have the lowest solubility for sulfur-bearing species. A survey of candidate solid electrolytes has led to the investigation of the lithium form of B-alumina. Author (GRA)

1972

1971

TK2896
.155
1970
v.1
47951

Energy 70, Intersociety Energy Conversion
Engineering; Las Vegas, Nevada-Sept. 21-25,
1970, Vol. 1

N71-35235# Mallory (P. R.) and Co., Inc., Burlington, Mass.
Lab. For Physical Science.
LONG SHELF LIFE ORGANIC ELECTROLYTE BATTERY
Final Report.

L. F. Athearn and A. N. Dey Fort Monmouth, N. J. ECOM Jun.
1971 78 p. refs
(Contract DAAB07-70-C-0076)

(AD-726385; ECOM-0076-F; Rept-4) Avail: NTIS CSCL 10/3
The fabrication of prototype organic electrolyte-lithium cells
having wide operating temperature range and high energy
density has been completed. Seventy of these cells were
assembled and delivered for evaluation tests. In tests of samples
of these cells carried out at this laboratory, energy densities of
95 watt hours per pound at room temperature and 55 watt
hours per pound at -30 C were obtained. Similar cell
components were assembled to make fifteen 36 volt batteries
with a diameter of 2.75 in. and a height of 5.0 inches. The
discharge of a prototype battery at room temperature using the
specified discharge regime was performed. Improved cells of the
type used to make the 36-volt batteries were tested at room
temperature on the specified loads. The contractual objective for
charge retention, high efficiency performance following three
months storage at 55C, was not attained. Reduced temperature
storage is recommended for the cells and batteries. Some
redesign of cell and battery structures is required to prevent
electrolyte leakage and internal corrosion observed in the
delivered end items.
Author (GRA)

A70-48388 Batteries and fuel cells. M. Barak. IEE
Reviews, vol. 117, Aug. 1970, p. 1561-1564. 48 refs.
Review of the progress achieved to date in the field of designing
portable and transportable power sources. The basic principles of
electrochemical power sources are outlined, and the manufacturing
processes and performance of the main types are briefly described.
Some details are given of new cell types capable of much higher
outputs than conventional batteries - in particular, sodium-sulphur,
lithium-chlorine, and zinc-air cells. Fuel cells are described in some
detail and indications are given of outstanding problems. Finally, the
characteristics of the various power sources are summarized, and the
relationships between the power and energy densities are illustrated
graphically.
O.H.

TK2921.M35

A70-42454 Batteries and energy systems. C. L. Mantell.
New York, McGraw-Hill Book Co., Inc., 1970. 231 p. 67 refs. \$14.
The construction, principles of operation, intended applications,
and technical specifications are given for all currently used com-
mercial types of batteries and energy systems. Preliminary sections
detail the fundamental theoretical concepts of batteries as sources of
electrical energy.

- HIGH ENERGY DENSITY NICKEL-CADMIUM CELLS/
A. Charley/M. Klein/Energy Research
Corporation. 3-1
- ELECTRICAL CHARACTERISTICS OF NICKEL-ZINC
SECONDARY CELLS/S. Charlip/S. Lerner/
Culton Industries, Incorporated 3-6
- HIGH ENERGY DENSITY LONG LIFE SECONDARY
SILVER-ZINC BATTERIES/J.K. Wilson/D. Standlee/
Eagle-Picher Industries, Inc./R.H. Kinsey/
S.R. Self/Lockheed Missiles and Space
Company. 3-9
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OF THE LI/M352 BATTERY SYSTEM/L.H. Gaines/
R. Jasinski/Tyco Laboratories. 3-15
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TELESCOPE MOUNT APPLICATION/W.H. Kirsch/
A. Shikoh /Sperry Rand Corporation 3-21
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BATTERY STATE-OF-CHARGE INDICATOR/
R.R. Secunde/ A. G. Birchenough/
Lewis Research Center/National Aeronautics
and Space Administration. 3-28
- AN ELECTROCHEMICAL CELL EQUIVALENT CIRCUIT
FOR STORAGE BATTERY/POWER SYSTEM CALCULAT-
IONS BY DIGITAL COMPUTER/R.G. Zimmerman/
Lockheed Missiles & Space Company/R.G.
Peterson/Lockheed Aircraft Corporation. 3-33

N71-22199# National Research Council of Canada, Ottawa
(Ontario). Low Temperature Lab
PRESENT STATUS OF ELECTRIC AUTOMOBILES
J. J. Gottlieb In its Quart. Bull. of the Div. of Mech. Eng. and
the Natl. Aeron. Estab., Oct.- Dec. 1970 31 Dec. 1970 p 1-38
refs (See N71-22198 11-15)
Avail: NTIS

The scope of the study includes developments in batteries,
fuel cells and hybrid systems, controllers, chargers, electric motors,
and body design features. Problems due to thermal conditioning
and corrosion are also discussed.
Author

Hietbrink, E. H., and Tricklebank,
S. B., "Electric Storage Batteries for
Vehicle Propulsion", ASME Paper 70-
WA/Ener-7, 1970.

£93

1969

FB-194.814
Little (Arthur D.), Inc., Cambridge, Mass.
PROSPECTS FOR ELECTRIC VEHICLES. A
STUDY OF LOW-POLLUTION-POTENTIAL
VEHICLES - ELECTRIC.

Oct 69, 105p APTD-69-52
Contract PH-86-67-108

Descriptors: (*Electric vehicles, Forecasting),
Automobiles, Forecasting), (*Electric batteries, Elec-
tric vehicles), (*Highway transportation, Electric
vehicles), Electric trucks, Buses (Vehicles), Alkali
metals, Storage batteries, Electric controllers,
Molten salt electrolytes, Thermal insulation, Elec-
tric motors, Fuel cells, Cost estimates, Refueling,
Hybrid propulsion, Weight (Mass), Metal air bat-
teries, Lead acid batteries, Battery chargers,
Research projects, Automobile bodies,
Aerodynamic drag.
Identifiers: *Air pollution control.

The major purpose of the research described was
to assess the state of the art in the technologies on
which the future development of electric highway
vehicles depends. The assessment is made on the
basis that there will be no major change in the pat-
terns of urban transportation and focuses upon the
technical requirements of the vehicle. As a
framework for the study, technical and, to a lesser
extent, cost criteria were established for six
classes of electric vehicles, most of which cor-
respond closely in performance to existing con-
ventionally powered types. On the basis of these
criteria the prospects for vehicle applications of
various electric motor and control systems and a
wide range of electrical power sources including
batteries, fuel cells, and engine-generator-battery
hybrids are compared. The most promising
systems for further development are identified and
the magnitude of the shortfall in their present
characteristics is estimated. Recommendations are
made for the expansion of future effort in these
areas, taking into account the expected contribu-
tions from existing programs in the public and
private sectors of the economy. The technology of
electric vehicles appears to be attainable, quite
possibly at an acceptable cost. A very substantial
technical effort is called for if the required
technologies are to be brought to maturity. The
technical risks of this endeavor are too great for
the investment to be borne by private capital
alone, particularly since the major objective is a
technology desirable for its social good rather than
for its profit potential. (Author)

Laumeister, B. R., "The G. E.
Electric Vehicle", General Electric
Co. Rpt. NO. 68-C-128.

N71-28674# National Aeronautics and Space Administration,
Goddard Space Flight Center, Greenbelt, Md.
NEW DEVELOPMENTS IN NICKEL-CADMIUM CELL
TECHNOLOGY AND ADVANCED ENERGY STORAGE
TECHNIQUES, SESSION 4
In its NASA/GSFC 1970 Battery Workshop [1970] p 351-454
(See N71-28672 16-03)
Avail: NTIS CSCL 10C

Research and development progress, new technology, and
test techniques related to energy storage devices are discussed.
Described in detail are: (1) pressure monitoring of cells by use of strain
gages; (2) sealable experimental cell cases for nickel cadmium
cells; (3) porous nickel plaque of honeycomb structure; and (4)
silver zinc storage cell usage and developments. A.L.

TK
2941
.F3
Falk, S. Uno.
Alkaline storage batteries, by, S. Uno Falk and, Alvin J.
Salkind. New York, Wiley, 1969,
xv, 656 p. illus., facsim., ports. 23 cm. (The Electrochemical
Society series)
Includes bibliographies.

TK
2921
.S95
1968
Symposium on Zinc-Silver Oxide Batteries,
Montreal, 1968.
Zinc-silver oxide batteries. Edited by
Arthur Fleischer, with John J. Lander.
New York, J. Wiley [1971]

xviii, 544 p. illus. 23 cm.

Held during the 1968 fall meeting of the
Electrochemical Society and co-sponsored by
the Battery Division of the Society and the
Air Force Aero Propulsion Laboratory.

U94

TK2896.I55 1967
32564

**Intersociety Energy Conversion Engineering Conference,
Miami Beach, Fla., 1967.**

Advances in energy conversion engineering; papers, cri-
tiques, and summaries. New York, American Society of Me-
chanical Engineers, 1967,

ELECTRIC AUTOMOBILE POWER

Chairman: William I. Reid

ELECTRIC AUTOMOBILES AND THE POWER INDUSTRY - M. S. Mashikian, T. A. Alessi, E. Hines	875
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SHORT DURATION LITHIUM-CHLORINE PRIMARY BATTERY SYSTEMS - E. H. Heitbrink, J. J. Petraitis, G. M. Craig	933

1974

(BNL-18719) APPLICATION OF METAL HYDRIDES TO GROUND TRANSPORT. Waide, C. H.; Reilly, J. J.; Wiswall, R. H. (Brookhaven National Lab., Upton, N. Y. (USA)). 1974. 11p. (CONF-740306-10). Dep. NTIS \$4.00.

From hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

Hydrogen, an alternative to gasoline fuel in vehicle applications, can be stored as a metal hydride and released for use by the application of waste heat from the engine. Present investigations include a review of known and possible hydrides with a potential for automotive use. Hydride bed types and their application to vehicles are discussed. FeTiH_x and MgH_2 are considered. Their merits and potential for use in meeting various transportation needs are discussed. Implementation through fleet vehicle systems is proposed as a means of gaining practical experience with reasonable control during the introduction of the advanced technology. (auth)

THE STORAGE OF HYDROGEN AS METAL HYDRIDES.

D.L. Cummings and G.J. Powers.

Ind. Eng. Chem., Process Des. Develop., v.13, no.2, 1974, p.182-192.

Metal hydrides offer a reversible, chemical means for storage of hydrogen and could be used as mobile and stationary fuel sources. The properties and uses of metal hydrides are reviewed. A magnesium hydride bed, used in a hydrogen-powered automobile, is modelled.

UNDERGROUND ENERGY STORAGE.

F.C. Rogers and W.E. Larson.

36th Annual Meeting of the American Power Conference, Apr.1974.

1974

(BNL-18720) MODELING STUDIES OF FIXED-BED METAL-HYDRIDE STORAGE SYSTEMS. Yu, W. S.; Smberg, E.; Waide, C. (Brookhaven National Lab., Upton, N. Y. (USA)). 1974. 14p. (CONF-740306-11). Dep. NTIS \$4.00.

From hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

Modelling studies are of a practical importance in understanding and characterizing the behavior of hydride beds now being developed for storing and supplying hydrogen fuel in power plant and automotive applications. A convection bed model, in which heat is transferred to or from the bed by a flowing stream of hydrogen in direct contact with the particles, and a conduction model in which heat is transferred through a containment wall, were developed. FeTiH_x and catalyzed MgH_2 were evaluated using the model. (auth)

1974

(BNL-18721) ROLE OF HYDROGEN IN ELECTRIC ENERGY STORAGE. Salzano, F. J.; Cherniavsky, E. A.; Leder, R. J.; Hoffman, K. C. (Brookhaven National Lab., Upton, N. Y. (USA)). 1974. 16p. (CONF-740306-9). Dep. NTIS \$4.00.

From hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

Electricity must be provided by the utilities on demand that varies daily, weekly, and in a seasonal cycle. This results in the under-utilization of high capital cost generating facilities and the reliance on peaking devices such as gas turbines and pumped storage. Gas turbine generators, though presently economical, are highly inefficient and use high grade liquid or gaseous fossil fuels which may eventually be in short supply. The role of electric storage in utility systems is discussed. The technology of hydrogen production, storage, and reconversion to electricity as a technique for electric energy storage is discussed and shown by means of an optimization model to fit well into the United States energy system. (auth)

THE HYDROGEN ECONOMY MIAMI ENERGY (THEME) CONFERENCE.

Presented by The School of Engineering &

Environmental Design, Univ. Miami, Coral Gables, Florida.

Sponsored by The National Science Foundation,
Defense Advanced Research Projects Agency,
and The School of Continuing Studies, Univ.
of Miami.

Miami Beach, Florida, Mar.18-20,1974.

Hydrogen Storage and Transmission

Session Chairman:

J. E. Johnson,
Union Carbide Corp.
Linde Division,
New York, New York

Session Co-Chairman: S. S. Lee, University of Miami,
Coral Gables, Florida

TRANSPORTATION AND STORAGE OF HYDROGEN

R. A. Reynolds, W. L. Slager, General Electric
Company, Santa Barbara, California

**ECONOMICS OF PIPELINE TRANSPORT FOR
HYDROGEN AND OXYGEN**

G. Beghi, Euratom, Ispra, Italy

**LOW THERMAL FLUX GLASS-FIBER TUBING FOR
CRYOGENIC SERVICE INCLUDING LH₂ STORAGE
SYSTEMS**

C. A. Hall, D. E. Spond, Martin Marietta Corp.,
Denver, Colorado

**ELECTRIC POWER AND FUEL TRANSMISSION BY
LIQUID HYDROGEN SUPERCONDUCTIVE PIPE-
LINE**

R. L. Whitelaw, Virginia Polytechnic Institute and
State University, Blacksburg, Virginia

**ARCHITECTURE OF AN AUTOMATIC SYSTEM FOR
SAFETY, METERING, AND CONTROL OF A
HYDROGEN TRANSMISSION PIPELINE**

J. G. Burgen, Teledyne Geotech, Garland, Texas

**OPTIMAL LOCATION OF HYDROGEN SUPPLY
CENTERS TO MINIMIZE DISTRIBUTION COSTS**

M. Avriel, V. Gurovich, Israel Institute of Tech-
nology, Haifa, Israel

HYDROGEN AS AN ENERGY CARRIER

R. G. Murray, Oklahoma State University, Still-
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**THE ROLE OF HYDROGEN IN ELECTRIC ENERGY
STORAGE**

F. J. Salzano, R. J. Isler, E. A. Cherniavsky, K. C.
Hoffman, Brookhaven National Laboratory, Long
Island, New York

**HYDROGEN ENERGY STORAGE FOR ELECTRICAL
UTILITY SYSTEMS**

C. Kippenhan, R. Corlett, University of Washing-
ton, Seattle, Washington

**AN ECONOMIC STUDY OF ELECTRICAL PEAK-
SHAVING ALTERNATIVES**

W. R. Parrish, U.S. Department of Commerce,
Boulder, Colorado

HYDROGEN AS ENERGY STORAGE ELEMENT

L. Zelby, The University of Oklahoma, Norman,
Oklahoma

THE HYDROGEN ECONOMY MIAMI ENERGY (THEME) CONFERENCE.

Presented by The School of Engineering &
Environmental Design, Univ. Miami, Coral
Cables, Florida.

Sponsored by The National Science Foundation,
Defense Advanced Research Projects Agency,
and The School of Continuing Studies, Univ.
of Miami.

Miami Beach, Florida, Mar.18-20,1974.

Metal Hydride Storage

Session Chairman: F. Schulman,
Fred Schulman Associates,
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Session Co-Chairman: W. B. King, University of Miami,
Coral Gables, Florida

**THE ACTIVATION OF A LANTHANUM-NICKEL-
FIVE HYDROGEN ABSORBENT**

H. H. van Mal, Philips Research Laboratories,
Geldrop, Netherlands

**AN ENGINEERING-SCALE ENERGY STORAGE
RESERVOIR OF IRON TITANIUM HYDRIDE**

G. Strickland, J. Reilly, R. Wiswall, Brookhaven
National Laboratory, Long Island, New York

**THE STORAGE OF HYDROGEN AS METAL
HYDRIDES**

D. L. Cummings, G. J. Powers, Massachusetts
Institute of Technology, Cambridge, Massachusetts

**MODELING STUDIES OF FIXED-BED METAL-
HYDRIDE STORAGE SYSTEMS**

W. S. Yu, E. Suuberg, C. H. Waide, Brookhaven
National Laboratory, Upton, New York

**THE SAFETY CHARACTERISTICS OF LaNi₅
HYDRIDES**

C. E. Lundin, University of Denver, Denver,
Colorado

**THE FORMATION AND PROPERTIES OF RARE-
EARTH AND TRANSITION METAL HYDRIDES**

L. C. Beavis, R. S. Blewer, J. W. Guthrie, E. J.
Nowak, W. G. Perkins, Sandia Laboratories,
Albuquerque, New Mexico

Hydrogen Storage in Vehicles

Session Chairman: L. W. Jones,
University of Michigan,
Ann Arbor, Michigan

Session Co-Chairman: J. Alexander,
University of Miami,
Coral Gables, Florida

**AMMONIA AS A HYDROGEN CARRIER AND ITS
APPLICATION IN A VEHICLE**

R. L. Graves, J. W. Hodgson, J. S. Tennant, The
University of Tennessee, Knoxville, Tennessee

**METAL HYDRIDES: EXPERIMENTAL METHODS
AND APPLICATION TO THE ELECTRIC VEHICLE**

P. Jonville, H. Stohr, R. Funk, M. Kornmann,
Battelle Centre de Recherche de Geneve, Geneva,
Switzerland

**THE APPLICATION OF METAL HYDRIDES TO
GROUND TRANSPORT**

C. H. Waide, K. C. Hoffman, J. J. Reilly, R. H.
Wiswall, Brookhaven National Laboratory, Long
Island, New York

**HYDROGEN STORAGE FOR AUTOMOBILES USING
METAL HYDRIDES AND CRYOGENICS**

R. E. Billings, Energy Research Corporation,
Provo, Utahs,

**STUDIES OF THERMAL STRATIFICATION IN LH₂
AUTOMOTIVE FUEL TANKS**

K. D. Williamson, Jr., J. R. Bartlit, F. J. Edeskuty,
W. F. Stewart, Los Alamos Scientific Laboratory,
University of California, Los Alamos, New
Mexico,

(BNL-18725) OPERATING MANUAL FOR THE P8E AND G HYDROGEN RESERVOIR CONTAINING IRON TITANIUM HYDRIDE. Strickland, G.; Reilly, J. J. (Brookhaven National Lab.; Upton, N. Y. (USA)). Feb 1974. 40p. Dep. NTIS \$8.00.

The manual was written for use with the experimental energy-storage system. Information is provided on how the reservoir functions and how it can be safely operated. In combination with a water electrolyzer and a fuel-cell stack, the hydrogen reservoir provides a new way of storing energy. The reservoir is the storage unit in the system; it is used to store hydrogen from the electrolyzer and subsequently release it to the fuel-cell stack. A reservoir for hydrogen consists of a closed vessel filled with granular metal hydride and provided with a particle barrier, a gas connection, and a means of handling the necessary thermal load. In this case the hydrogen is stored as iron titanium hydride in a pressure vessel; porous metal tubing is used for the barrier, and an internal heat exchanger is provided to handle the thermal load. The hydride may be cycled many times provided gaseous impurities that degrade its performance are excluded from the system. Water at readily available temperatures (approximately 60 and 120°F) is suitable for use as the heat exchange medium. Tests have shown that design specifications may be exceeded. It will take up H_2 at a rate >1.5 lb/hr, deliver it at a rate >1.0 lb/hr, and its working capacity is significantly more than the 10 lb of H_2 originally specified. A compressor (500-psig rating) is required to pressurize H_2 leaving the electrolyzer in order to obtain a practical sorption rate. The temperature and flow rate of the water in the heat exchanger tubes also are an important factor with respect to sorption and desorption rates. (MCW)

(BNL-18634) ENGINEERING-SCALE ENERGY STORAGE RESERVOIR OF IRON TITANIUM HYDRIDE. Strickland, G.; Reilly, J. J.; Wiswall, R. H. Jr. (Brookhaven National Lab., Upton, N. Y. (USA)). Feb 1974. 13p. (CONF-740306-12). Dep. NTIS \$3.00.

From hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

A hydrogen reservoir containing 14 lb of H_2 in the form of 893 lb of granular iron titanium hydride was constructed and tested. The reservoir will be used by Public Service Electric and Gas Co. of New Jersey to study the feasibility of storing off-peak electrical energy through the use of a water electrolyzer, a hydride reservoir, and a fuel cell stack. The internal functional components of the stainless steel vessel consist of a barrier in the form of porous metal tubes, and heat exchanger tubes. Details of construction, preparation of the hydride, and performance tests made at BNL are described. (auth)

N74-19694 Escher Technology Associates, St. Johns, Mich. A PROBLEM STATEMENT: OCEAN BASED SOLAR-TO-HYDROGEN ENERGY CONVERSION MACRO SYSTEM. William J. D. Escher and Joe A. Hanson (Oceanic Inst.) Nov. 1973. 25 p refs.

Copyright. Avail: Issuing Activity CSCL 10A

An ocean based solar to hydrogen energy conversion facility is proposed that uses hydrogen as an energy carrier to be delivered to the spectrum of the energy using sector, instead of electricity, because of hydrogen's advantages of transportability and storability. The solar to hydrogen conversion process is conducted on the open ocean, and not in the traditional desert location. A number of coproducts that can also be supplied by the proposed ocean complex includes sea foods, salts, fertilizers, magnesium, and aluminum materials. Author

METALLIC HYDROGEN STORAGE MATERIAL: HIGH COMPRESSION AND SAFE STORAGE OF THE GAS POSSIBLE. VDI (Ver. Deut. Ing. Nachr.; 27: No. 44, 15/Oct 1973). (In German).

One of the recent important achievements of the research work carried out in the Philips laboratories is the discovery of metallic hydrogen storage devices. The metallic storage material is described by the formula AB_2H_x , with A standing for rare earth, B for either cobalt or nickel, and H for hydrogen. Hydrogen being added to $LaNi_5$, e.g., will result in the formation of the hydride $LaNi_5H_6$, with six H atoms being bound to one unit, whereas in $SrNiCo_4$, 2.5 H atoms are added to the compound. (GE)

N74-16780* Oklahoma State Univ., Stillwater.
ENERGY STORAGE USING HIGH PRESSURE ELECTROLYSIS AND METHODS FOR RECONVERSION
 William L. Hughes *In NASA, Lewis Res. Center* Wind Energy Conversion Systems Dec. 1973 p 123-129 (For availability see N74-16757 08-03)
 CSCL 10C

Theoretical and experimental studies on high pressure electrolysis producing hydrogen and oxygen for energy storage and reconversion are reported. Moderate temperature, high pressure hydrogen/oxygen fuel cells with nickel electrodes are investigated for effects of pressure, temperature, and membrane porosity. Test results from an aphorid burner turbine generator combination obtained 40 percent kilowatt hours out of the fuel cell divided by kilowatt hours into the electrolyzer. It is concluded that high pressure hydrogenation of organic materials can be used to synthesize hydrocarbons and methanes for making synthetic vehicular fuels.
 G.G.

TITLE: Heat-Storage Wells for Conserving Energy and Reducing Thermal Pollution

AUTHOR: Meyer, C.P.; Todd, D.K.
CORPORATE AUTHOR: General Electric-REPO, Center for Advanced Studies; University of California, Berkeley, Dept. of Civil Engineering.

ADDRESS: GE, Santa Barbara, CA; UC, Berkeley, CA
PUBLICATION DESCRIPTION: Paper 739121 presented at 8th Intersociety Energy Conversion Engineering Conference held at University of Pennsylvania, Philadelphia, PA, Aug. 13-17, 1973, P. 428-432 of Proceedings, 10 references
PUBLICATION DATE: 1973

ABSTRACT: Storing large amounts of useful heat in groundwater appears feasible. Preliminary analysis shows that more than three-fourths of the stored heat can be recovered after 90 days; heat-storage wells cost less than the cooling facilities they replace; and the necessary underground formations are widely available. For each unit of electricity generated today, two units of low-temperature heat energy typically are wasted. Higher temperature heat (350 degrees Fahrenheit) is usable for space heating, absorption air conditioning, water heating, and process heat. Heat at 350 degrees Fahrenheit can be recovered from the exhaust gases of combustion gas turbines. Nuclear central stations using a topping or backpressure cycle also can provide heat at 350 degrees, with good thermodynamic efficiency because credit is taken for the exhaust heat. This heat can be transmitted in large quantities with acceptable loss. Heat storage can provide the bridge that is needed between the spring and fall seasons when heating and cooling loads are light, thus making electrical and heat outputs compatible and enabling exhaust heat to be utilized on a large scale. (Auth)

AVAILABILITY: American Institute of Aeronautics and Astronautics, Order Dept., 1290 Avenue of the Americas, New York, NY 10019 (\$60.00 for entire proceedings)

N74-16781* General Electric Co., Santa Barbara, Calif.
USE OF HYDROGEN AND HYDROGEN-RICH COMPOUNENTS AS A MEANS OF STORING AND TRANSPORTING ENERGY
 Walter Hausz *In NASA, Lewis Res. Center* Wind Energy Conversion Systems Dec. 1973 p 130-134 (For availability see N74-16757 08-03)
 CSCL 10C

A one-megawatt wind energy source is assumed that uses half of its output to serve customers as electricity, and stores the other half by conversion to hydrogen, to liquid hydrogen, to stored LH₂, and back to electricity. Energy costs and capital costs of the conversions escalate unit costs to 12.9 cents per kilowatt hour. High conversion costs can be reduced by using Mg₂NiH₄ and FeTiH₂ storage, or by using a 100- or 1000 megawatt system.

N74-17871*

(LA-5406-MS) SODIUM: CLEAN-ENERGY STORAGE MEDIUM FOR VEHICULAR POWER. Brown, W.K. (Los Alamos Scientific Lab., N. Mex. (USA)). Sep 1973. Contract W-7405-eng-36. 10p. Dep. NTIS \$4.00.

Metallic sodium is proposed as an energy storage medium to provide pollution-free power for virtually all forms of land, sea, and air transportation. Ideally, electrical energy from

efficient, central, nuclear-powered plants would be used in the reduction of ordinary salt to sodium, which would subsequently be carried in vehicles and reacted with water to produce mechanical energy in a hydrogen-fueled engine. Lvc. the sole combustion product, would be recycled for continuing use. The scheme appears to offer a competitive alternative to the use of cryogenic hydrogen for vehicular power. (auth)

TITLE: Conservation and Better Utilization of Electric Power by Means of Thermal Energy Storage and Solar Heating, Phase III - Progress Report

AUTHOR: Yeh, H.
CORPORATE AUTHOR: Pennsylvania, University of
PUBLICATION DESCRIPTION: Report No.
NSF/RANM/SE/S127976/PR73/1, 30 p.
PUBLICATION DATE: 1973, March

TITLE: Congruently Melting Materials for Thermal Energy Storage in Air Conditioning

AUTHOR: Kauffman, K.; Pan, Y.-C.

CORPORATE AUTHOR: University of Pennsylvania, National Center for Energy Management and Power; University of Pennsylvania, Towne School of Civil and Mechanical Engineering

ADDRESS: Philadelphia, PA 19104

PUBLICATION DESCRIPTION: Report No. NSP/RANW/SE/GI27976/TR73/5, 19 p., 7 references

PUBLICATION DATE: 1973, June

SPONSOR: National Science Foundation, RANN Program

ABSTRACT: Because of the as yet unsolved difficulties in utilizing sodium sulfate decahydrate mixtures as phase change materials suitable for thermal energy storage for air conditioning, an effort was made to find suitable materials which melt congruently. A congruently melting material would need no homogenizing or thickening agents, but could have other problems, such as a slow rate of nucleation or a slow rate of crystal growth. A suitable material must melt within the required temperature range, possess a high latent heat (heat of fusion) per unit volume, be inexpensive, stable, and noncorrosive. Two classes of materials were investigated: inorganic hydrates and organics. After an extensive literature survey, samples of potentially suitable materials were obtained and calorimetrically tested. A number of paraffin waxes were identified as promising thermal energy storage materials. (Auth)

TITLE: Conservation and Better Utilization of Electric Power by Means of Thermal Energy Storage and Solar Heating, Phase IV - Progress Report

AUTHOR: Yeh, H.

CORPORATE AUTHOR: University of Pennsylvania

ADDRESS: Philadelphia, PA 19176

PUBLICATION DESCRIPTION: Report No. NSP/RANW/SE/GI27976/PR73/2

PUBLICATION DATE: 1973, June 30

SPONSOR: National Science Foundation, RANN Program

ABSTRACT: Concern for maintaining reliable and economical energy supplies and for supplying electrical power demand has led to the examination of techniques for better utilization of existing resources. The use of thermal energy storage and solar energy to provide comfort conditioning by methods which consume less fuel and require less peak power is to be studied. One task of the project is the investigation of off-peak air conditioning systems which perform such of the power consuming function at night. This would reduce peak daytime loads on summer peaking utilities. A second project task is the use of solar energy for heating residential buildings. This would reduce fuel consumption. Both of these systems involve heat storage to deliver the required commodity, heating or cooling, subsequent to the time when the commodity is best obtained. This logically led to a third project task: the investigation of materials for storing thermal energy. The economic conditions required for successful introduction of the novel systems are to be defined, and the effect of such systems on electric utilities are to be investigated. (Auth, Objectives)

TITLE: Thermochemistry of Salt Hydrates

AUTHOR: Belton, G.; Ajami, P.

CORPORATE AUTHOR: University of Pennsylvania, National Center for Energy Management and Power; University of Pennsylvania, Towne School of Civil and Mechanical Engineering

ADDRESS: Philadelphia, PA 19104

PUBLICATION DESCRIPTION: Report No. NSP/RANW/SE/GI27976/TR73/4, 91 p.

PUBLICATION DATE: 1973, May

SPONSOR: National Science Foundation, RANN Program

ABSTRACT: This report describes research performed on materials suitable for thermal energy storage (TES) applied to solar heating and air conditioning of buildings. Following a brief survey of the various means of TES, it is shown that the latent heat of fusion offers the best possibility for these applications. The thermal energy that can be stored by this method is of the order of 50 plus or minus 10 cal/gm (90 plus or minus 18 Btu/lb). Criteria for candidate materials are developed, and the various classes of materials that undergo a phase transformation at the required temperatures are briefly reviewed in that light. Most of the report, then, concentrates on one class of materials: inorganic salt hydrates. An extensive literature survey on phase diagrams and thermodynamic properties of salt hydrates was carried out; its results are presented in the appendices. The kinetics of nucleation of the solid from the melt are considered from the theoretical point of view, since past studies indicate that supercooling is a serious problem in these materials. An empirical relationship between the viscosity of the melt at the melting point and its tendency to supercool is developed. It is found that salt hydrates are half-way between the good glass formers (which strongly supercool) and the non-glass formers (which do not supercool); as a result, it is suggested that the use of outside agents, such as a small weak supersonic field, may prevent supercooling. The recommendations for future work include a search for new materials both within and outside the classes mentioned, and a detailed study of the kinetics of nucleation of salt hydrates. (Auth)

TITLE: Thermal Energy Storage Unit for Air Conditioning Systems Using Phase Change Material

AUTHOR: Dudley, J.C.

CORPORATE AUTHOR: University of Pennsylvania, National Center for Energy Management and Power; University of Pennsylvania, Towne School of Civil and Mechanical Engineering

ADDRESS: Philadelphia, PA 19104

PUBLICATION DESCRIPTION: Report No.

NSP/RANW/SE/GI27976/TR72/8, 23 p.

PUBLICATION DATE: 1972, August

SPONSOR: National Science Foundation, RANW Program

ABSTRACT: A thermal energy storage unit using salt hydrate material was designed for an off-peak air conditioning system. The unit is sized for a two ton peak load and a one ton daily average load. It is suitable for use with the prototype reconder thermal energy storage air conditioning system constructed at the University of Pennsylvania. Based on the stated characteristics of Na₂SO₄.10H₂O the unit has a rated capacity of 100,000 Btu. The heat transfer surface is a stack of 12 horizontal aluminum sheets, spaced one inch apart, with imbedded refrigerant passages. The uniqueness of this design is that the refrigerant is in intimate thermal contact with the phase change thermal storage material. The unit is suitable for use in air conditioning coolness storage systems or in space heating storage systems with suitable choices of materials. It has a smaller volume than a thermal energy storage unit using the sensible heat of water. However, it is more expensive.----A cost

comparison between a conventional refrigeration unit and recondering off-peak units storing thermal energy in water or in phase change materials shows the latter to be the most expensive unit, even if the phase change material is obtained at zero cost. Only the lower space requirements justify the continued development effort on phase change materials suitable for air conditioning thermal energy storage. (Auth, Abstract modified)

TITLE: System and Economic Analysis, for Off-Peak Air Conditioning

AUTHOR: Saaty, T.L.; Lapide, L.; Tinkleman, H.

CORPORATE AUTHOR: University of Pennsylvania, National Center for Energy Management and Power; University of Pennsylvania, Towne School of Civil and Mechanical Engineering

ADDRESS: Philadelphia, PA 19174

PUBLICATION DESCRIPTION: Report No.

NSP/RANW/SE/GI27976/TR72/1a, 76 p.

PUBLICATION DATE: 1972, August

SPONSOR: National Science Foundation, RANW Program

ABSTRACT: An economic model of off-peak air conditioning systems was created in order to evaluate the relationship between equipment cost and power reduction. Cost and power reductions were determined for operational control policies varying from continuous operation to exclusively off-peak operation for a range of costs of thermal energy storage material. Economic evaluations were performed with current electrical rates and with postulated discounts for systems designed for off-peak operation. It was

determined that without subsidy the minimum cost system was the one using a continuously operating compressor. This system requires the smallest compressor and the least thermal energy storage material. The incremental cost of systems with larger compressors and more thermal energy storage (which would further reduce the power demand during peak periods) was evaluated in order to have a basis for comparison with the cost of the incremental generation capacity. Depending on the cost of the thermal energy storage material, the system costs range from slightly advantageous to slightly disadvantageous. Incremental implementation strategies were postulated for the introduction of off-peak air conditioning systems over a given planning period. (Auth)

**CONSERVATION AND BETTER UTILIZATION OF ELECTRIC
POWER BY MEANS OF THERMAL ENERGY STORAGE AND
SOLAR HEATING, PHASE II - PROGRESS REPORT.**

Altman, M.

Pennsylvania, Univ. Report No. NSF/RANN/GL27976/
72/4. Dec.1972. 70p.

TK2896. I55 1972

TITLE: Off-Peak Air Conditioning Using Thermal
Energy Storage

AUTHOR: Freeman, S.I.; Dudley, J.C.

CORPORATE AUTHOR: Pennsylvania, University of

PUBLICATION DESCRIPTION: Paper 729183 presented
at 7th Intersociety Energy Conversion
Engineering Conference 1972 held at San
Diego, CA, published in Proceedings p.
1256-1262

PUBLICATION DATE: 1972, September

TITLE: Hydrogen for Energy Transport and Storage
in Solar Energy Systems
AUTHOR: Hoffman, K.C.; Winsche, W.E.
CORPORATE AUTHOR: Brookhaven National Laboratory
PUBLICATION DESCRIPTION: BNL 16259,
CONF-711035-1, paper presented at Third
Conference on Large Scale Solar Energy
Conversion for Terrestrial Use, 6 p.
PUBLICATION DATE: 1971

N73-10976# Pennsylvania Univ., Philadelphia. Towhe School
of Civil and Mechanical Engineering.

**CONSERVATION AND BETTER UTILIZATION OF ELECTRIC
POWER BY MEANS OF THERMAL ENERGY STORAGE AND
SOLAR HEATING** Interim Report, 1 Feb. 1 Jul. 1971

Manfred Altman 1 Oct. 1971 265 p refs
(Grant NSF GL-27976)

A project to investigate the application of heat and coolness
storage for comfort heating and air conditioning was initiated.
Inexpensive salt hydrates exhibiting phase change temperatures
between 40 F and 60 F were found appropriate with use of
off peak generation of coolness for storage and subsequent use
during peak demand periods to supplement or replace electrical-
ly powered air conditioning units. Other inexpensive salt hydrates,
with phase change temperatures of 89 F to 195 F were found
for use as heat storage materials with solar heat collectors and
off peak electric heating units. A feasibility demonstration of the
off peak air conditioning system was built and successfully
tested.

Author (GRA)

TK2896. I55 1972

(BNL-16889) METAL HYDRIDES FOR ENERGY

STORAGE. Wiswall, R. H. Jr.; Reilly, J. J. (Brookhaven Na-
tional Lab., Upton, N. Y.). 1972. 22p. (CONF-720928-6).
Dep. NTIS.

From seventh intersociety energy conversion engineering con-
ference; San Diego, CA. (25 Sep 1972).

The use of metal hydrides as hydrogen reservoirs facilitates
the storage and subdivision of central-station power for automo-
tive and other purposes. Hydrides with a wide range of proper-
ties have been synthesized and studied, and several appear to
have promise for specific storage applications. Results are re-
ported on the effect of alloy constituents on hydride stability; on
the formation of hydrides by metals reacting with gas mixtures
such as those produced by the steam reforming of hydrocarbons;
and on the feasibility of integrated systems of hydride reservoir
plus engine or fuel cell. (auth)

TITLE: Thermal Energy Storage in Rock Chambers, A
Complement to Nuclear Power

AUTHOR: Margen, P.H.

CORPORATE AUTHOR: AB Atomenergij

PUBLICATION DESCRIPTION: A/CONF.49/P/798, Paper
presented at Fourth International Conference
on the Peaceful Uses of Atomic Energy,
Geneva; published in Peaceful Uses of Atomic
Energy, Vol. 4, 177-194

PUBLICATION DATE: 1971, September

1967

TK2896.I55 1967

USE OF ENERGY STORAGE WITH UNCONVENTIONAL ENERGY SOURCES TO AID DEVELOPING COUNTRIES.

K.A. McCollom.

Advances in Energy Conversion Engineering, 1967
Intersociety Energy Conversion Engineering Conference,
Aug.13-17, 1967, Miami Beach, Fl., p.813-819.

Development of an energy storage system using electrolysis of water to produce hydrogen and oxygen has led to an investigation of the use of unconventional energy sources in assisting developing countries

TL500.N6 no.81

N68-17798 Pennsylvania Univ., Philadelphia
PROSPECTS FOR THERMAL ENERGY STORAGE

Manfred Altman In AGARD Combust and Propulsion 1967
p 135-149 refs
(Grant NSG-316)

This paper is concerned with the problem of developing a method of storing thermal energy by the utilization of the heat of fusion of suitable compounds. The first part of the paper discusses the incentives for the development of this type of energy storage. The second part deals with the problem of synthesizing suitable materials. The third part discusses the problem of obtaining the needed heat transfer properties. The main conclusions of this work are as follows. (1) A good case can be made for space power systems utilizing thermal energy storage. (2) This is predicated on technical developments which appear probable, but which have not yet been accomplished. (3) A great deal of work remains to be done in two major research areas. One, the determination of phase diagrams of promising eutectic mixtures, and two the experimental and theoretical determination of heat transfer properties. (4) A carefully planned systematic approach is needed to obtain the information necessary for systems comparisons.

Author

N66-16538* # Pennsylvania Univ., Philadelphia. Inst. for Direct Energy Conversion.
THERMOPHYSICAL AND TRANSPORT PROPERTIES OF HIGH TEMPERATURE ENERGY STORAGE MATERIALS
R. A. Sharma and H. Chang [1964] 42 p refs Presented at the 3d Ann. Symp., Tucson, Ariz.
(Grant NSG-316)
(NASA-CR-53807) CFSTI: HC \$2.00/MF \$0.50 CSCL 10C

The paper describes the prospective thermal energy storage materials and the techniques to be used for the measurements of their thermo physical properties, such as melting points, heats of fusion, and thermal transient transport properties. On the basis of the data available in the literature, several metals and compounds appear to be promising thermal energy storage materials. The suitability of the eutectic mixtures of certain oxides and fluorides is shown by making the estimations of their heats of fusion.

Author

N63-17682

Callery Chemical Co., Pa.

DETERMINATION AND ANALYSIS OF THE POTENTIALITIES OF THERMAL ENERGY STORAGE MATERIALS [Final] Technical Report. [July 1, 1961 - Aug. 30, 1962]

K. W. Boehm and H. W. Wilson et al Wright-Patterson AFB, Ohio, Directorate of Aeromechanics, Jan. 1963 113 p 10 refs

(Contract AF 33(616)-7224)

ASD-TR-61-187, Pt. 11)

N-100,895

DETERMINATION AND ANALYSIS OF THE POTENTIALITIES OF THERMAL ENERGY STORAGE MATERIALS. H.W. Wilson, K.W. Boehm and W.J. Cooper. (Covers work from May 1960-June 1961). June 30, 1961. 117p.

Callery Chemical Co.
Aeronautical Systems Div.
Contract AF-33(616)-7224
TR 61-187

Thermal energy storage methods may be classified as chemical methods (heat of reaction) and physical methods (heat of fusion). This study screened various groups of compounds which might be applicable to these methods of heat storage. The results of a literature search are discussed and the physical property data are tabulated. Experimental results and descriptions of the apparatus and methods used for experimentally determining physical properties are presented. The heat transfer characteristics of three basic heat storage configurations (storage material in cylindrical capsules, storage material in thin blocks conforming to the shape of the liners, and storage material in thin blocks conforming to the shape of the working fluid reservoir) using heat of fusion are described. The storage of 400 BTU/lb of storage material was the objective of this work.

1961 W,L 4718/E-B/9-14-61/16

Materials - Heat
Heat of reaction
Heat of fusion
Materials - Temperatures, High
Materials - Properties, Physical
Heat transmission - Materials
Furnaces
Bibliography - Materials
12.3

1973

GAS TURBINE SYSTEMS USING UNDERGROUND COMPRESSED AIR STORAGE.

D.L. Ayers and D.Q. Hoover.

36th Annual Meeting of the American Power Conference, Apr. 1974.

TITLE: Air Storage Peaking Power Plants - Utilizing Modified Industrial Gas Turbines and Cavities Created With Nuclear Explosives
AUTHOR: Fryer, B.C.
CORPORATE AUTHOR: Battelle, Pacific Northwest Laboratories

ADDRESS: Richland, WA 99352
PUBLICATION DESCRIPTION: Report No. BNWL-1769, 33 p., 19 references

SPONSOR: U.S. Atomic Energy Commission
PUBLICATION DATE: 1973, May
ABSTRACT: Efforts to reduce the cost of peaking power have led to a reconsideration of the air storage type peaking plant. In this peaking plant concept air is compressed and stored in a chamber during low demand periods. During peak demand periods air is withdrawn from the cavity, fired with fuel, heated in a combustion chamber, and expanded through a turbine producing electrical power. This report summarizes a preliminary economic and technologic assessment of an air storage peaking power plant utilizing a modified industrial gas turbine and air storage cavities created with nuclear explosives. Cost estimates indicate that the air storage plant based on current gas turbine technology could produce peak power at significant savings over other types of plants, provided: (1) air storage properties are conducive to the production of a high void volume per kiloton of explosive. Cost estimates based on 1980 gas turbine technology indicate that the air storage system is clearly economically competitive to other peaking systems -- even under the worst possible conditions of air storage temperature and rock properties. (Auth)

TK2896.I55 1973

TITLE: Compressed Air Energy Storage Systems Characteristics

AUTHOR: Decher, R.
CORPORATE AUTHOR: University of Washington, Dept. of Aeronautics and Astronautics
ADDRESS: Seattle, WA 98195

PUBLICATION DESCRIPTION: Paper 739122 presented at 8th Intersociety Energy Conversion Engineering Conference held at University of Pennsylvania, Philadelphia, PA, Aug. 13-17, 1973. P. 433-440 of Proceedings

PUBLICATION DATE: 1973

SPONSOR: Seattle City Light
ABSTRACT: An analysis of compressed air energy storage has been carried out to determine the feasibility of its use in commercial power peak shaving. The study identifies several system configurations which are characterized by the vessel pressure and the cyclic pressure variation. These configurations are shown to be thermodynamically superior to pumped hydrostorage when state of the art turbine engine components are used. The energy storage cost of such systems is shown to be potentially competitive depending on energy recovery requirements, land costs, the availability of natural caverns or the vessel manufacturing costs. The relative importance of component performance is delineated in this study. The behavior of the vessel's temperature and pressure over various time scales is discussed. Practical means of minimizing the system capital cost are outlined. (Auth)

AVAILABILITY: American Institute of Aeronautics and Astronautics, Order Dept., 1290 Avenue of the Americas, New York, NY 10019 (\$60.00 for entire proceedings)

AIR STORAGE: THE ALTERNATIVE PEAK POWER SOURCE. Jeffs, E. Energy Int., 10: No. 9, 23-25(Sep 1973).

The need for energy storage is increasing with the advent of more nuclear power plants. Where lack of water or unsuitable terrain rule out pumped storage, air storage systems based on gas-turbine technology provide an economic and easily deployed alternative. Unlike a conventional gas-turbine generator package, the compressor and turbine stages are mounted on separate shafts at opposite ends of a motor-generator set and coupled to it via clutches. At night the compressor is coupled to the electrical machine, which functions as a motor. The compressor feeds air at high pressure into an underground storage cavern. In the daytime peak periods the turbine is coupled to the machine that now serves as a generator. Air is discharged from the cavern, into a combustion chamber and then to the power turbine. Some preheating of the air can be arranged by means of an exhaust heat recuperator. The storage cavern is excavated beneath a lake, or the sea, so that a constant air pressure can be maintained by hydrostatic means. If no water is available, air can be delivered at constant volume over a decreasing pressure range. (MCW)

HD9540.4. I5 1973

An air storage gas turbine project in Sweden—overall concept and operating features. B. Nordstrom, N. Holmin, I. Cedell (Swedish State Power Board, Vallingby).

1973 IEEE International Convention and Exposition. Vol. III, New York, USA, 26-30 March 1973 (New York, USA: IEEE, 1973), 13.1/7pp.

In an air storage gas turbine power station, air is during the night compressed into an underground storage. During the peak-load period in the day, the compressed air is utilized for operation of the gas turbine for what reason all the turbine power can be used for production of electricity, as no simultaneous compression is required. Such a plant for the unit size about 200 MW and the pressure 25 bar and for ultimately 10 hours daily output is studied in Sweden in order to be constructed in the late 1970's. The authors report general design and especially the role and value of the station in the power system. (5 refs.)

N74-16786* InterTechnology Corp., Warrenton, Va.

ENERGY STORAGE BY COMPRESSED AIR

George C. Szego. In NASA Lewis Res. Center Wind Energy Conversion Systems. Dec. 1973. p 152-154 (For availability see N74-16757 08-03)

CSCL 10C

The feasibility of windpower energy storage by compressed air is considered. The system is comprised of a compressor, a motor, and a pump turbine to store air in caverns or aquifers. It is proposed that storage of several days worth of compressed air up to 650 pounds per square inch can be used to push the aquifer up closer to the container dome and thus initiate piston action by simply compressing air more and more. More energy can be put into it by pressure increase or pushing back the water in the aquifer. This storage system concept has reheated flexibility and lowest cost effectiveness.

G.G.

Pumping-generating units for the Grand Coulee pumping-generating plant. C.B. Brown (Bur. Reclamation, Boise, Idaho, USA), E.M. Tomsic.

IEEE Trans. Power Appar. & Syst. (USA), vol. PAS-92, no. 3, p.1057-64 (May-June 1973). (received: Oct. 1973)

The Grand Coulee Pumping-Generating Plant is the primary source of water for the vast Columbia Basin Irrigation Project. Two new units will be installed to serve dual purposes of irrigation pumping and pumped storage generation. This paper covers the plans of the United States Bureau of Reclamation for integrating the two new pumping-generating units into the ultimate 45 hydroelectric unit complex at Grand Coulee Dam. (3 refs.)

Operation of Seneca pumped storage plant. J.P. Fitzgerald (Cleveland Electric Illuminating Co., Ohio, USA), E.A. Cooper, F.P. Solomon. IEEE Trans. Power Appar. & Syst. (USA), vol. PAS-92, no. 5, p.1510-16 (Sept.-Oct. 1973).

The Seneca pumped storage plant has been in commercial service since 14 Jan 1970. Synchronous starting of large reversible generator/motors by means of a small generator has proved to be highly reliable and the overall efficiency of the station ranges from 71 to 79 percent. Design modifications made since start-up are described. (4 refs.)

LUDINGTON PUMPED STORAGE PROJECT. Connell, E. (Ebasco Services Inc., New York), J. Power Div., Amer. Soc. Civil Eng.: 99: No. PO1, 69-88(May 1973).

The Ludington pumped storage project, when completed at the end of 1973, will have a 1,872-Mw installed capacity. The upper reservoir with 53,000 acre-ft usable vessel is formed by a 6-mile long earth-fill dam with a sandwich type asphalt facing. The six penstocks are encased in concrete, under the embankment, and buried in silty sand on the slope. At the intake structure the gates are suspended by hoists that allow for fast emergency closure. A prestressed, precast, concrete baffle wall serves as vortex suppressor and ice barrier. The intake apron, with splitter walls is an energy dissipator for the pumped water energy. The powerhouse, constructed on clay, is protected by a breakwater and two jetties. The 6-312-Mw units are remotely operated and are started in pumping by the synchronous back-to-back method and pony motor. (auth)

HIDDEN VIEW OF PUMPED STORAGE. Energy Int.: 10: No. 11, 44-45(Nov 1973).

The Ludington, Michigan Pumped Storage Project will be the largest facility of its kind in the world. The large man-made reservoir will serve as a 1872 megawatt peaking plant for the production of electrical power. At low demand periods, electrical power supplied from conventional or nuclear plants will pump water from Lake Michigan through large diameter steel penstocks to storage in the reservoir. At peak demand periods, the reservoir water will be released down the penstocks to the powerhouse turbines to produce electricity. The production parameters and assembly of the project are described. The penstocks are buried. (MCW)

ENVIRONMENTAL DESIGN OF BEAR SWAMP PROJECT.
ECT. Kwiatkowski, R. W. (Charles T. Main, Inc., Boston);
Pierce, L. D. J. Power Div., Amer. Soc. Civil Eng.; 99: No.
PO1, 205-215(May 1973).

The civil engineering design of the Bear Swamp pumped storage hydroelectric project required cognizance of the effect upon environment along each stage of the major design decisions. Final configurations and treatment of reservoir slopes, borrow areas, surface features and recreational facilities took into account the impact of cost as well as potential detrimental effect upon both the immediate and the areal vicinity. After a brief project description, selection of the underground powerhouse is explained followed by a description of the considerations behind the location and procedure for the exploratory adit. Details aimed at preventing any future oil contamination of the reservoir by trans- former accident are illustrated. The exterior architectural treatment of the two small power plants, which are integral parts of the project, is related to the environment from the standpoint of blending into the surroundings. Finally, the effect upon the Deerfield River and construction limitations are touched upon. (auth)

THINGS THAT GO PUMP IN THE NIGHT.

A. Lovins.
New Scientist, May 31, 1973, p.564-566.

House of Commons reported favourably on the Central Electricity Generating Board's proposal for a massive hydroelectric pump storage project in the heart of Snowdonia. This article critically surveys the economic basis of the scheme.

RACCOON MOUNTAIN PUMP/TURBINES ARE WORLD'S LARGEST. Energy Int.; 10: No. 1, 18-20(Jan 1973).
The four 400-MW reversible pump/turbines ordered for the Tennessee Valley Authority's Raccoon Mountain pumped-storage project are the largest machines of their type ever built. The design and fabrication techniques used are described. (LCL)

Recent experience at Cabin Creek pumped-storage hydroelectric project. F. W. Easton (Public Service Co., Colorado, Denver, USA).
Proceedings of the American Power Conference. Vol. 35, Chicago, Ill., USA, 8-10 May 1973 (Chicago, Ill., USA: Illinois Inst. Technol., 1973). P.971-9.
The Cabin Creek Pumped-Storage Hydroelectric Project is located 35 miles west of Denver, high in the Rocky Mountains. Major features include the lower dam and reservoir, powerhouse, and switchyard at an elevation of 10,000 feet in the South Clear Creek Valley, the upper dam and reservoir in a narrow glacial valley just above the powerhouse at an elevation of 11,200 feet, and the power tunnel connecting the upper reservoir and powerhouse. (no refs.)

ELECTRICAL EQUIPMENT FOR THE VILLARINO PUMPED STORAGE.

Pantli, W. Brown Boveri Rev.; 60: No. 5, 196-204(May 1973).

Pumped storage schemes form an ideal complement for thermal power stations. On the one hand they cover peak loads and, on the other, contribute towards economical utilization of excess energy during the night and at weekends. The electrical equipment supplied by Brown Boveri for the Villarino pumped storage scheme, the largest plant in Spain and one of the largest in Europe with reversible pump turbines is described. (auth)

OPERATION OF SENECA PUMPED STORAGE PLANT.

Fitzgerald, J. P. (Cleveland Electric Illuminating Co.); Cooper, E. A.; Solomon, F. P. IEEE (Inst. Elec. Electron. Eng.), Trans. Power App. Syst.; PAS-92: No. 5, 1510-1516(1973).

The Seneca pumped storage plant has been in commercial service since January 14, 1970. Synchronous starting of large reversible generator/motors by means of a small generator has proved to be highly reliable and the overall efficiency of the station ranges from 71 to 79 percent. Design modifications made since start-up are described. (auth)

1972

TITLE: Pumped Storage and Tidal Power in Energy Systems

AUTHOR: Haswell, C.K.; Mantington, S.B.; Shaw, T.L.; Thorpe, G.M.; Westwood, T.J.
CORPORATE AUTHOR: Charles Haswell and Partners; University of Bristol, Dept. of Civil Engineering

ADDRESS: Charles Haswell and Partners, London, England; University of Bristol, Bristol, England

PUBLICATION DESCRIPTION: Journal of the Power Division, Proceedings of the American Society of Civil Engineers, 98(PO2), 201-220

PUBLICATION DATE: 1972, October
ABSTRACT: A detailed study is presented of the most effective method to use tidal power from an economic and engineering standpoint. The non-daily cycle of tides can best be used in conjunction with pumped storage in off-peak hours. This energy to be supplied by thermal plants. This concept is applied to the Severn estuary in England; other advantages such as recreation and navigation could be achieved. (JWC)

TITLE: Development of Pumped Storage Facilities in the United States - 1972

AUTHOR: Kasikas, J.N.
CORPORATE AUTHOR: Federal Power Commission
PUBLICATION DESCRIPTION: Paper presented before the Symposium on Hydroelectric Pumped Storage Schemes, Economic Commission for Europe, United Nation's Economic and Social Council, Evgenidion Foundation, Athens, Greece, November 6-8, 1972

PUBLICATION DATE: 1972
ABSTRACT: The development of pumped storage has paralleled the development of the reversible pump-turbine. Most are built for electric production. They are used to guarantee adequate stress flow and for peaking capacity. Tables are included showing projects which are complete, those under construction, and those in the planning stage. On May 1, 1972 there were 3700 MW in operation, 8500 MW under construction, and 15,000 MW in advanced stages of planning. (JMC)

TITLE: Underground Air Storage and Electrical Energy Production

AUTHOR: Korfmeier, R.B.
CORPORATE AUTHOR: Oak Ridge National Laboratory, ORNL-NSF Environmental Program
PUBLICATION DESCRIPTION: ORNL-NSF-EP-11, 17 p.
PUBLICATION DATE: 1972, February

OPTIMAL PUMPED STORAGE OPERATION WITH INTER-CONNECTED POWER SYSTEMS.

M.J. Cobian.
IEEE Trans. Power App. & Syst., v.PAS-90,
May/June 1971, p.1391-

Abstract- This paper deals with the problem of obtaining the optimal scheduling of a pumped storage hydroelectric plant in combination with several interconnected power systems. A special case of interest is the scheduling of pumped storage when the plant is jointly owned by several electric utilities. A mathematical model is developed in order to determine the power flows between the different power systems and the pumped storage plant as well as the water flows inside the plant.

A new formulation of this problem is presented which is able to account for changes in the operating characteristics of a pumped storage plant due to significant variations in the head and operating efficiencies of the plant. The mathematical model proposed is essentially a state-bounded nonlinear optimal control problem with a plant capable of operating in a dual mode, namely, pumping and generation. The model developed is primarily an operational one although it can also be used for planning purposes to analyze the behavior of a pumped storage plant under different operating conditions and to predict the corresponding savings due to pumped storage operation.

SUBSURFACE PUMPED STORAGE AND ENVIRONMENT.
R.L. Loofbourow.

CORPORATE AUTHOR: Multipurpose Excavation Group
PUBLICATION DESCRIPTION: Paper presented at the International Conference on Pumped Storage Development and its Environmental Effects, University of Wisconsin, Milwaukee, Wisc., -September 1971

PUBLICATION DATE: 1971, September

TITLE: Pumped Storage Development and its Environmental Effects

AUTHOR: Karadi, G.M. (Ed.); Krizek, R.J. (Ed.); Csallany, S.C. (Ed.)
CORPORATE AUTHOR: American Water Resources Association

PUBLICATION DESCRIPTION: Proceedings of an International Conference held at the University of Wisconsin - Milwaukee, September 19-24, 1971, 572 p.
PUBLICATION DATE: 1971

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LAKE DELIO PUMPED-STORAGE HYDROELECTRIC PLANT
AND POWER PRODUCTION IN ITALY.

G. Baroncini.

IEEE Trans. Power App. & Syst., V.PAS-90,
Sept./Oct.1971, p.2108-

Abstract—After indicating the importance of the role played by pumped-storage hydroelectric plants in Italian power production the author discusses ENEL's construction program relating to this type of plant.

Detailed reference is made to the Lake Delio pumped-storage hydroelectric plant, now at an advanced stage of construction; in terms of capacity (1,000 MW for generation, 760 MW for pumping) it will be the largest hydroelectric plant in Italy.

PUMPED STORAGE AT ORCVILLE-DESIGN AND INITIAL
OPERATION.

G.F. Wachter.

IEEE Trans. Power App. & Syst., v.PAS-90,
May/June 1971, p.1217-

Pumped storage equipment has played a significant role in the storage and distribution of water at Oroville. This paper describes the mechanical design features of the pump/turbines installed in the Edward Hyatt Power Plant, and the many tests performed during design and startup to achieve water delivery requirements. The experiences gained from this installation should stimulate the further development of pumped storage by utilities and consulting engineers.

ENERGY REGULATION IN LARGE POWER SYSTEMS BY
PUMPING STATIONS.

A.M. Angelini.

IEEE Trans. Power App. & Syst., v.PAS-89, no.8,
Nov./Dec.1970, p.2079-

Having set forth general information on Italy's power system, the paper discusses the reasons why a considerable expansion of pumping stations is anticipated in this country. With reference to some of the hydroelectric pumped-storage stations existing or under construction in Italy, a few considerations are made concerning the characteristics which such stations can assume with respect to hourly, daily, weekly and seasonal regulation, integration and reserve.

TITLE: Combined Hydroelectric Pumped Storage and Nuclear Power Generation

AUTHOR: Susskind, H.; Raseman, C.J.

CORPORATE AUTHOR: Brookhaven National Laboratory

PUBLICATION DESCRIPTION: BNL 50238 (T-574), 83 p.

PUBLICATION DATE: 1970, April

TITLE: A Dynamic Programming Approach for Determining the Optimal Dispatching Sequence for a Combined Hydro-thermal-pumped-storage Utility System

AUTHOR: Joy, D.S.

CORPORATE AUTHOR: Oak Ridge National Laboratory

PUBLICATION DESCRIPTION: ORNL-4624, 34 p.

PUBLICATION DATE: 1970, November

ELECTRICAL DESIGN ASPECTS OF MUDDY RUN PUMPED
STORAGE PLANT.

J.J. Ferencsik.

IEEE Trans. Power App. & Syst., v.PAS-88, no.8,
Aug.1969, p.1302-

Abstract—A general description is given of the physical plant and electrical system and a rather detailed description of the automatic controls of the Muddy Run pumped storage hydro plant. Conventional controls are used for generating and spin modes and modifications to these controls are made for the pumping mode. In pump mode operation the generator-motors (G-M) are started as induction motors on half voltage and are transferred to full voltage after synchronizing. The design includes remote automatic operation utilizing conventional supervisory control equipment over microwave channels. A digital computer is used to economically load the eight G-Ms.

74V37039 1969 ISS 00 TD201.V57 NO. 21 551.4808 S LC-78-628673 TD370

A/SIMMONS, G. M.

THE EFFECT OF PUMPED-STORAGE RESERVOIR OPERATION ON BIOLOGICAL
PRODUCTIVITY AND WATER QUALITY #BY: G. M. SIMMONS, JR., AND S. E. NEFF.
WATER RESOURCES RESEARCH CENTER, VIRGINIA POLYTECHNIC INSTITUTE,
BLACKSBURG, 47 P. ILLUS., MAP. 23 CM.
#VIRGINIA POLYTECHNIC INSTITUTE, BLACKSBURG. WATER RESOURCES
RESEARCH CENTER. BULLETIN 21 BIBLIOGRAPHY. P. 45-46.
LC WATER QUALITY -- VIRGINIA -- SMITH MOUNTAIN LAKE. LIMNOLOGY --
SMITH MOUNTAIN LAKE, VA. PUMPED STORAGE POWER PLANTS -- SMITH MOUNTAIN
LAKE, VA.

ADDED N#US#VA NEFF, S. E., JOINT AUTHOR.

MAIN-AUTH TRACE-SEES#TITL#AUTH# CATLG BY-LC

ELECTRICAL DESIGN AND TESTING OF CABIN CREEK
PUMPED-STORAGE HYDROELECTRIC PROJECT.

L.M. Robertson, et al.

IEEE Trans. Power Apparatus & Systems, v.Pas-87,
no.3, Mar.1968, p.844-

Abstract—The design, construction, and testing of one of the world's highest altitude high head pumped-storage projects presented extraordinary challenges to equipment designers, project design and construction engineers, as well as the testing and operating engineers. Considerations are described that lead to the selection of the major equipment, including the demands of high altitude upon the electrical design criterion. The two generator/motors are believed to be the world's largest 360 r/min synchronous machines. Special procedures for separate balancing of the generator/motor before coupling to the pump/turbine, and balancing techniques utilizing a full range of controlled speed balancing steps made possible by the wound rotor induction starting motor, have resulted in completed machines having exceptionally fine balance. The extensive instrumentation has provided not only a sound basis of testing during start-up, but also a complete hydraulic, mechanical, and electrical record of initial plant and system performance.

AN INVESTIGATION OF PUMPED STORAGE SCHEDULING.

C.D. Galloway.

IEEE Trans. Power Apparatus & Systems, v.PAS-85,
no.5, May 1966, p.459-

Abstract—This paper describes how a digital computer program intended for system planning studies was used to investigate several questions related to pumped storage planning and operation. Among the items investigated were reservoir size, the influence of cycle efficiency on pumped storage capacity factor and operating cost, and the effect of load forecasting deviations on system economy. A brief description of the program is provided.

A COMPUTER PROGRAM FOR DETERMINING THE ECONOMIC SIZE
OF DEVELOPMENT OF PUMPED-STORAGE HYDRO SITES.

M. Schneek and C.W. Watchorn.

IEEE Trans Power Apparatus and Systems, v.PAS-85,
no.11, Nov.1966, p.1154-

Abstract—This is a companion paper to an earlier one.¹ The computer program described is divided into three parts: a) the determination of the coefficients for (1), (2), and (4) of Watchorn¹ for the best fit to the calculated cost and plant pumping ratio data, b) the determination of the lowest average unit investment cost, and other pertinent information, to be shown later, for each of the potential sites for various conditions, and c) the arrangement of the results of part b in the order of preference. All the programs are written in Fortran for the 7074 computer.

DISPATCHING PUMPED STORAGE HYDRO.

G.H. McDaniel.

IEEE Trans. Power Apparatus & Systems, v.PAS-85,
no.5, May 1966, p.465-

Abstract—While the economic factors associated with the planning and design of a pumped storage hydro project must include system operation concepts, the day to day operation of a given pumped hydro project presents a different set of economic decisions. In this connection, the array of data or information that must be presented to the dispatcher is, of necessity, different in form from that presented to the planner. Therefore, the scope of discussion is limited to the problem of day to day and minute to minute scheduling and dispatching pumped storage hydro in combination with steam generating capacity in an optimum manner. The example used for discussion is the Smith Mountain pumped storage project.

HYDROTHERMAL DISPATCH WITH PUMPED STORAGE.

E.S. Bainbridge, et al.

IEEE Trans. Power Apparatus & Systems, v.PAS-85,
no.5, May 1966, p.472-

Abstract—A method is presented for optimizing the weekly or daily dispatch of a power system consisting of 16 hydro plants, 4 thermal plants, and a pumped storage plant. The main features of the method are: treatment of hydro plants in cascade on a river and its tributaries with freedom for heads to vary at each plant; allowances for hydro units out of service; optimum thermal unit scheduling, including the effect of start-up costs; maintenance of a minimum spinning reserve requirement in each interval in the scheduling period; inclusion of speed-no-load losses and head variation effects in scheduling pumped storage units. The optimization techniques and salient features of a computer program using these techniques are presented, together with numerical schedules from a pilot study based on a system model.

SOME GENERAL BASIC PLANNING CHARACTERISTICS OF PUMPED-STORAGE HYDRO CAPACITY.

C.W. Watchorn.

IEEE Trans Power Apparatus & Systems, v.PAS-84,
June 1965, p.464-

Abstract: This paper first discusses the effect of limited energy hydro capacity, including pump-storage hydro capacity, on system installed capacity requirements, showing that, for a combined thermal and hydro system, the capacity value of the hydro depends primarily on the reduction in the maximum thermal generation requirements that can be effected over the heavier daily peak load hours. Such determinations are inseparable from the load characteristics and the effect of prior installed limited energy capacity. Second, a mathematical basis is presented for the evaluation of the relative economics of alternative potential pump-storage sites based on operating requirements, and for the determination of the most economical size of development for various conditions.

A METHOD FOR ECONOMIC SCHEDULING OF A COMBINED PUMPED HYDRO AND STEAM GENERATING SYSTEM.

B.J. Bernard, et al.

IEEE Trans. Power App. & Sys., v.PAS-83, Jan.1964,
p.23-

Summary: This paper describes a method for the optimum scheduling of pumped storage hydro in combination with a steam generating system. It also describes a computer program which determines weekly operating schedules for a pumped hydro station. The techniques developed can be used to evaluate future peaking capacity of this type and to estimate long-term operating costs for different combinations of steam and pumped storage capacity.

THE PRESENT STATE OF PUMPED STORAGE IN EUROPE.

H.K. Happoldt, et al.

IEEE Trans. Power App. & Syst., v.PAS-82, Oct.
1963, p.618-

Summary: Pumped storage in Europe dates back to the late 19th Century with strong upsurges in the 1930's and 1950's. It is used for various purposes, the extremes of which are seasonal storage and peaking. The paper lists all major pumping stations with complete engineering data, discusses the various possible arrangements of the machinery, the types of pumps and turbines available today, and the coupling and shaft arrangements. A few typical storage and peaking operations are described in some detail. After a short review of the economic aspects, a separate chapter is devoted to reversible pump-turbine units.

24N22706** ISSUE 14 PAGE 1632 CATEGORY 3 NASA-CR-2383
SD-73-SA-0101-1 NAS1-11732 74/04/00 303 PAGES UNCLASSIFIED
DOCUMENT

INTEGRATED POWER/ATTITUDE CONTROL SYSTEM (IPACS) STUDY. VOLUME 1:
FEASIBILITY STUDIES --- APPLICATION OF FLYWHEELS FOR POWER STORAGE AND
GENERATION FINAL REPORT

A/NOTTI, J. E.; B/CORMACK, A.; III; C/SCHMILL, W. C.
ROCKWELL INTERNATIONAL CORP.; DOWNEY, CALIF. (SPACE DIV.)
AVAIL. NTIS HC \$7.25

WASHINGTON NASA
/♦ATTITUDE CONTROL/♦ENERGY CONVERSION/♦ENERGY SOURCES/♦ENERGY
STORAGE/♦FLYWHEELS/ EQUIPMENT SPECIFICATIONS/ PERFORMANCE TESTS/
SYSTEMS ENGINEERING

1974

Letter to the editor by F. J. Hooven and a letter
by R. P. Post and Stephen F. Post on the flywheel.
Sci. Amer., v.230, no. 3, Mar. 1974, p. 8-10.

The Messrs Post letter amplifies some points made
in their earlier article in Scientific American,
v.229, no. 6, Dec. 1973, p.17-23.

FLYWHEELS.

R.F. Post and S.F. Post.

Sci. Amer., v.229, no.6, Dec.1973, p.17-23.

New designs could be used for the storage
of energy in electric power systems.

THE SUPER FLYWHEEL: A SECOND LOOK, E.J. Brunelle

Jour. of Eng. Mat. and Tech, Trans. of ASME,
Ser. M, v.95, no.1, p.63, Jan. 1973

N74-16783* Applied Physics Lab., Johns Hopkins Univ., Silver
Spring, Md.
SUPERFLYWHEEL ENERGY STORAGE SYSTEM
David W. Rabenhorst In NASA. Lewis Res. Center Wind
Energy Conversion Systems Dec. 1973 p 137-145 refs (For
availability see N74-16757 08-03)
CSSL 10B

A windpowered system using the superflywheel configuration
for energy storage is considered. Basic elements of superflywheels
are thin rods assembled in pregrooved hub lamina so that they
fan out in radial orientation. Adjacent layers of hub lamina are
assembled 90 degree in rotation to each other so as to form a
circular brush configuration. Thus stress concentrations and rod
failure are minimized and realistic failure containment for a high
performance flywheel is obtained.
G.G.

1973

NEW UNINTERRUPTIBLE POWER SYSTEM ALTERNATIVES USING HIGH CAPACITY KINETIC ENERGY WHEELS. The application of recent military/aerospace technological advances in kinetic energy wheel design to the field of Uninterruptible Power Systems (UPS) provides new system alternatives which overcome the limitations of previous UPS configurations (both of the inverter-battery and rotating, no-break types). These improvements result from the availability of practical flywheels with energy storage capacities at least ten times greater than those previously applied to UPS. The high capacity kinetic energy storage in conjunction with improved control systems can provide true, no-break systems in which the characteristic frequency droop of flywheeled UPS sets is minimized. The new on-line UPS incorporating a kinetic energy wheel, in addition to providing a full-rated UPS capability, offers the advantages of continuous power factor correction, transient suppression, and nearly instantaneous peaking capability.

Lawson, Lewis J. Lockheed Missiles & Space Co., Sunnyvale, Calif. *IEEE Ind Appl Soc. Annu Meet. 8th Conf. Rec. Pap. Milwaukee, Wis. Oct 8-11 1973* p 1510156. Publ by IEEE (73 CHO 763-31A). New York, 1973.

N74-20709# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.

DESIGN CONSIDERATIONS FOR A 100-MEGAJOULE/500-MEGAWATT SUPERFLYWHEEL

David W. Rabenhorst and Robert J. Taylor Dec. 1973 87 p refs

(Contract N00017-72-C-44011)

(AD-774736; APL-TG-1229) Avail: NTIS CSCL 10/1

The magnitude of stored energy required in high power bursts for modern experiments in physics has reached the point where capacitor banks previously used for this purpose are no longer practical. Although flywheels have been proven to be less expensive for this purpose and are one-hundredth the size, even the practicality of future flywheel-powered systems is being challenged by the magnitude of future experiment energy requirements. An existing steel flywheel capable of delivering 100 MJ at a rate of 100 MW costs \$1,500,000 and weighs 60,000 pounds. Future experiments may require 20 times this energy. The report describes a Superflywheel having a design goal of delivering 100 MJ at a rate of 500 MW. Its projected cost is less than \$50,000. Also, it appears to be readily scalable to the larger size required for future experiments. Author (GRA)

S-447

HYBRID CAR: PART-TIME ENGINE + PART-TIME FLYWHEEL = E.F. Lindsley.

Popular Science, Aug. 1973, p. 68, 69, 125.

After months of computer studies and flywheel tests, Lockheed is ready to go ahead and build a prototype.

THE REVOLUTION IN FLYWHEELS.

Richard T. Dann, Assistant Ed.

Machine design May 17, 1973, 130-135.

ROTATING FLYWHEEL STUDIED FOR URBAN TRANSIT USE.

Av. Ark & Space Technology, Sept 10, 1973.
p. 46.

TK 2896. I55 1972

TITLE: Flywheel Energy Buffer

AUTHOR: Jakubowski, R.

CORPORATE AUTHOR: IBM Systems Development Division

PUBLICATION DESCRIPTION: Paper 729170 presented

at 7th Intersociety Energy Conversion

Engineering Conference 1972 held at San

Diego, CA, published in Proceedings p.

1141-1145

PUBLICATION DATE: 1972, September

BUILDING THE WIND-UP TUBE TRAIN.

New Scientist, Apr.10,1972, p.334,335.

Uses energy stored in a flywheel.

ENERGY STORAGE OF SUPER FLYWHEELS.

N.V. Gulia and L.D. Lunkin.

Russ. Eng. Jour., USSR, v.52, no.12, 1972, p.3-

THE APPLICABILITY OF WOOD TECHNOLOGY TO KINETIC
ENERGY STORAGE. (Superflywheels)

API Technical Digest May-June 1972, 2-12.

TK 2896. I55 1971

Potential applications for the superflywheel; D.W. RABENHORST;
SAE, Intersociety Energy Conversion Eng Conf, Boston, Mass., Aug
3-5 1971 paper 719146 p 1118-25;

Flywheel and flywheel/heat engine hybrid propulsion systems for
low-emission vehicles; G.L. DUGGER, A. BRANT, J.F. GEORGE, L.
L. PERINI; SAE, Intersociety Energy Conversion Eng Conf, Boston,
Mass., Aug 3-5 1971 paper 719149 p 1126-41; 28 refs.

Design and testing of high energy density flywheels for applica-
tion to flywheel/heat engine hybrid vehicle drives; L.J. LAWSON;
SAE, Intersociety Energy Conversion Eng Conf, Boston, Mass.,
Aug 3-5 1971 paper 719150 p 1142-50;

Evaluation of hybrid heat engine/electric systems for low exhaust
emission potential in automotive applications; D.E. LAFEDRES, J.
MELTZER; SAE, Intersociety Energy Conversion Eng Conf, Boston,
Mass., Aug 3-5 1971 paper 719151 p 1161-63;

CN-128,662 also N72-11410 # 1971

FLYWHEEL FEASIBILITY STUDY AND DEMONSTRATION.

R.R. Gilbert, J.R. Harvey, G.E. Heuer, et al. (Final
rept.). Apr.30,1971.

Lockheed Missiles and Space Co. LMSC-D007915
National Technical Information PD 200 143
Contract EES 70-104

The purpose of this study is to determine the feasibility of the flywheel as a means of
attaining low-emission propulsion systems for urban vehicles. A further objective is
the demonstration and performance evaluation of full-scale flywheels for hybrid
applications.

RESULTS AND CONCLUSIONS

The flywheel/heat-engine hybrid drive appears to be a technically feasible means of
emission reduction for the family car, commuter car, city bus, and delivery/postal
van.

A flywheel/hybrid family car using a spark-ignition engine may approach the Clean
Air Act emission standards.

A flywheel/hybrid family car using one of several engines of projected 1975 availability
might have emissions below the Clean Air Act standards.

A73-14744 Material requirements for the superflywheel.
D. W. Rabenhorst (Johns Hopkins University, Silver Spring, Md.). In:
Opportunities in materials; Proceedings of the Fourth Buhl International Conference, Pittsburgh, Pa., November 16-18, 1971. (A73-14740 04-17) Pittsburgh, Carnegie Press, 1971, p. 195-205, 7 refs.

The superflywheel configurations utilize essentially straight filaments or thin rods. The new superflywheels have demonstrated a capability of storing about 30 watt-hours per pound. It appears certain that with growing operational experience the energy storage capacity will be significantly improved. Potential applications of the new device are related to vehicles, tools, power supplies, aircraft, spacecraft, and watercraft. A general description of the superflywheel system is given. Materials cost is discussed together with environmental aspects, materials stress and weight.

G.R.

THE WINDUP CAR.

K. Hohenemser and J. McCaull.
Environment, v.12, no.5, June 1970,
p.14-21,32.

For the long range, an alternative to the fumespewing internal combustion engine is needed. The superflywheel is a simple and promising candidate. A spinning flywheel would be "wound up" at night by electric power, and would run a bus, or even a car, all day, silently and completely without air pollution.

TK2896. I55 1970

A73-25979 # New concepts in mechanical energy storage. D. W. Rabenhorst (Johns Hopkins University, Silver Spring, Md.). In: Energy 70; Proceedings of the Fifth Intersociety Energy Conversion Engineering Conference, Las Vegas, Nev., September 21-25, 1970. Volume 1. (A73-25976 11-03) Hinsdale, Ill., American Nuclear Society, 1972, p. 2-95 to 2-99, 12 refs.

A unique flywheel configuration is described which provides a new level of applicability for present and future anisotropic materials, including whisker materials. An energy storage capability of 30 watt-hours per pound of flywheel weight should be readily available, while performance in excess of this value is predicted for the future. Some additional improvements described include (1) a magnetic fluid hermetic seal that makes it possible to locate bearings and other equipment outside the vacuum can for lower drag and better lubrication, and (2) a new magnetic fluid bearing.

T.M.

N70-22637# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
PRIMARY ENERGY STORAGE AND THE SUPER FLYWHEEL
D. W. Rabenhorst Sep. 1969 65 p refs
(Contract N0w-62-0804-C)

(AD-697906; APL-TG-1081) Avail: CFSTI CSCL 10/3
This report describes new flywheel configurations that promise an order of magnitude improvement as energy storage devices. As presently conceived, the energy density has been improved over ten times, with the prospect for additional improvement in performance as the next generation of high strength uniaxial filamentary materials becomes available. This super flywheel is significant in its application to the urban electric vehicle. Instead of only being used to reduce the acceleration power requirements, as has been proposed in many studies, the new flywheel can actually be used as the primary energy source, and batteries can be eliminated altogether. Many other applications are also discussed.

Author (TAB)

A68-12853

Composite Flywheel Stress Analysis and Materials Study, G.F. MORGANTHALER, S.P. RONK. See Aerospace Matl & Process Engrs--Advances in Structural Composites--SAMP6 Nat Sympo-sium. 12th Oct 10-12 1967 Sec D-6, 14 p. Feasibility of producing light weight, high-strength flywheels for short-term energy storage by using composite Fiberglass-Epoxy structure; on basis of analysis, flywheel was designed and tested; inner ring was analyzed, and it was found that analytical technique correctly predicted stress distributions in wheel; as result of test, working values for radial properties of composite material were determined, analytical techniques were verified, and possibility of delamination-type of failure instead of conventional burst-type failure was demonstrated.

06185

Utilization of Flywheel Energy. R.C. CLERK. SAE--Paper 7114 for meeting June 10-14 1963 36 p. Stored flywheel energy can be used individually or in combination in 3 ways--by dissipation in overcoming resistances, by exchange to potential energy, and by kinetic transfer to another mass; last method offers greatest potential; various applications are described--inertia motor starter, inertia lift autogyro, RAE (Royal Aeronautical Establishment) aircraft catapult, flywheel vehicle propulsion, electrolyro for use in motor buses, and Gyreacta recuperative transmission, etc; schematics.

**N64-27115 Westinghouse Electric Corp., Pittsburgh, Pa.
ENERGY GENERATION OR LONG DURATION STORAGE
BY DYNAMIC METHODS**

L. A. Kilgore, W. Wright, and C. H. Church *In Inst. for Defense Analyses Proc. of the IDA Pulse-Power Conf.*, Feb. 4-5, 1963, Vol. IV Jul. 1963 p 97-98 (See N64-27101 19-06)

A scheme is presented that consists of a multiplicity of large flywheel generator sets that produce the power during the pulse operation from the stored energy in the flywheel. Each individual set would produce about 500 mw for 100 sec, and would slow down from 720 rpm to 360 rpm during the 500-mw 100-sec period. Twenty-two flywheels would be used per generator, with bearings between flywheels. Each flywheel is made up of laminated high-strength steel with a 205-in. diameter and 120-in. in length. Hydraulic turbine generators, such as those used at Niagara Falls, are also described.

R. T. K.

Determining Inertia and Time Requirements for Flywheel Machines. M. F. SPOTTS. *Machine Design* v 38 n 9 Mar 28 1963 p 148-51. Dynamical analysis of flywheel machine so that various requirements of load cycles can be met; analysis takes into account fact that torque of induction motors by which such machines are usually driven, increases as speed decreases.

Testing Magneto Flywheels at Speeds up to 25,000 r.p.m. Machy (Lond.) v 103 n 2645 July 24 1963 p 184-5. Tests in question were necessary to insure that flywheel which is in form of aluminum alloy pressure die casting, with permanent magnets, poles and steel center cast in position, would not disintegrate at any speed at which Villiers Sarmaker 250-cc motor cycle engine for "scrambles" and short circuit racing is likely to be run; description of high speed testing machine which is designed to stop automatically when bursting or excessive distortion of flywheel occurs and speed is recorded.

Short-term Flywheel APU is Light and Simple. N. M. FRUKTOW. *J. VENTURA Space/Aeronautics* v 35 n 6 June 1961 p 59-61. Advantages of power supply systems based on principle of storing energy in flywheel; analysis of flywheel auxiliary power unit as hydraulic power source for operation of missile vernier controls after sustainer burnout; 2 design variants could be used, one with separate hydraulic pump and motor and one with combination motor pump; in both cases motor is powered by hydraulic supply of main stage to spin up flywheel which later drives pump to provide power for verniers.

SUPERCONDUCTIVITY: LARGE-SCALE APPLICATIONS.

R.A. Hein.

Science, v.185, no.4147, July 19, 1974, p.211-222.

This article is an overview of areas involving large-scale applications of superconductivity for which the 1970's are a decade of critical decision. Applications to superconducting solenoids, high-energy physics, electric power transmission, rotating electrical machinery, energy storage and transfer, and superconducting magnets for superfast trains.

Energy and Superconductivity.

National Bureau of Standards, Boulder, Colo. Cryogenic Data Center. 20 Mar 74, 36p B-1153

COM-74-10713/7WE PCS7.00/MFS7.00

Contents: Generators, motors, transmission lines, transformers, thermonuclear fusion, MHD, magnets, miscellaneous applications, refrigeration, patents, and reviews.

N74-16430 Wisconsin Univ., Madison.
SUPERCONDUCTIVE ENERGY STORAGE INDUCTORS FOR POWER SYSTEMS Ph.D. Thesis

Narendra Mohan 1973 111 p
Avail: Univ. Microfilms Order No. 73-20286

Large toroidal magnets with superconductive windings could serve to perform a system function equivalent to hydro pumped storage. In sizes greater than 1,000 MW-hrs, preliminary economic studies have shown some promise. It is demonstrated by means of computer simulation that the power flow through the energy storage inductor can be reversed within a few cycles using a conventional Graetz converter bridge with an appropriate control. A system with interconnected stream-electric areas is simulated on the hybrid computer. The system performance, with and without the energy storage device, is studied in response to the random load changes. The deviation of area frequency from the normal and the change in tie line power flow are used as error signals for controlling the energy storage inductors. Dissert. Abstr.

N73-31876*# Kanner (Leo) Associates, Redwood City, Calif.
SUPERCONDUCTIVE ENERGY STORAGE
S. L. Wipf Washington NASA Sep. 1973 43 p refs Transl.
into ENGLISH of "Supraleitende Energiespeicher", Max-Planck-Inst. fuer Plasmaphys., Garching, West Germany, report IPP-2/211, Feb. 1973 39 p
(Contract NASw-2481)

(NASA-TT-F-15109; IPP-2/211) Avail: NTIS HC \$4.25 CSCL 20L

Superconductive energy storage is surveyed with regard to advantages, problems and applications. Advantages are large capacity and discharge rate, and relatively high energy density. Problems are optimization of coil form, discharge, development of a suitable superconducting switch, and minimization of alternating-current losses in order to maintain superconduction during discharge. Some proposed solutions are outlined. Envisaged applications include pinch experiments in plasma physics directed toward a pulsed fusion reactor, and power supply for lasers. Author

(LA-5377-MS) ECONOMICS OF SUPERCONDUCTING MAGNETIC ENERGY STORAGE SYSTEMS FOR LOAD LEVELING:

A COMPARISON WITH OTHER SYSTEMS. Hassenzahl, W. V.; Baker, B. L.; Keller, W. E. (Los Alamos Scientific Lab., N. Mex.).

Aug 1973. Contract W-7405-eng-36. 20p. Dep. NTIS \$4.00.

The capital costs of superconducting magnetic energy storage systems are calculated for various geometries, sizes, and support configurations. These are used as a basis for calculating, for a variety of operating conditions, the cost of delivered energy, which forms the basis of a comparison with other load-leveling systems. For certain configurations and operating conditions, superconducting magnetic energy storage is shown to be competitive with other load-leveling systems. (auth)

N73-26054# Magnetic Corp. of America, Waltham, Mass.
DEVELOPMENT OF PULSED HIGH ENERGY INDUCTIVE ENERGY STORAGE SYSTEMS. VOLUME 3: WEIGHT OPTIMIZATION FOR ENERGY STORAGE. COIL CRYOGEN AND DEWAR Technical Report, Apr. 1971 - Apr. 1972
 Edward J. Lucas, William F. B. Punchard, and Richard J. Thorne
 Wright-Patterson AFB, Ohio AFAPL Dec. 1972 109 p
 (Contract F33615-71-C-1454; AF Proj. 3145)
 (AD-755360; AFAPL-TR-72-38-Vol-3) Avail: NTIS CSCL 10/2

The report provides weight estimates for possible configurations which may be used in one of these subsystems, that which is devoted to energy storage. For the purposes of this study, it will be assumed that the energy storage subsystem consists of three components: (1) the cryogenic coils, (2) the cryogen and (3) the dewar. The limits of the subsystem are the electrical terminals entering and leaving the dewar. All other components are assumed to be located in other subsystems. The method of determining the weights of the components of the subsystem will be discussed, followed by a discussion of the manner in which subsystems were optimized. The section closes with tables giving characteristics of weight optimized systems for a range of energy, pulse length, total pulses, wire diameter, and copper to superconductor ratio.

N72-26856# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Stuttgart (West Germany). Inst. Energiewandlung und Elektrische Antriebe.
ENERGY STORAGE IN SUPERCONDUCTING COILS
 C. Carpentis 6 Mar. 1972 59 p refs In GERMAN; ENGLISH summary
 (DLR-FB-72-10) Avail: NTIS HC \$5.00; DFVLR Porz-Wahn; 20. DM

The storage of energy in superconducting coils and the capital costs of such a practice are discussed. The field intensity in the coil, the current density of the superconductor, and a characteristic dimension of the coil are related to the geometry of coil and the energy stored in it. Such data allows optimization of the coil with respect to its specific mass. A comparison of the superconducting coil with other energy storage systems revealed that the superconducting systems are characterized by relatively low specific mass and low capital costs, especially where high discharge power is required.

Author

N74-11067# Arco-Everett Research Lab., Everett, Mass.
DEVELOPMENT OF A PULSED HIGH-ENERGY INDUCTIVE ENERGY STORAGE SYSTEM. Final Technical Report
 J. Tanno, O. K. Sonju, and J. M. Lontai Aug. 1973 308 p refs

(Contract F33615-71-C-1455; AF Proj. 3145)
 (AD-766518; AFAPL-TR-73-49) Avail: NTIS CSCL 09/1
 The work was concerned with the complete investigation and feasibility demonstration of superconducting inductive energy storage systems capable of producing high power pulses in the 200 microsecs range on a repetitive basis. The system studied was a 100 kJ system. A 15 kJ model system was successfully tested. Also, as part of the program, a complete investigation of switches appropriate for short pulse inductive energy storage systems was made. The investigation led to the preliminary development of a multiple contact high speed switch which was successfully tested in model size. (Modified author abstract)

GRA

N74-19375# Los Alamos Scientific Lab., N.Mex.
DESIGN OPTIONS AND TRADEOFFS IN SUPERCONDUCTING MAGNETIC ENERGY STORAGE WITH IRREVERSIBLE SWITCHING

H. L. Laquer, J. D. G. Lindsay, E. M. Little, J. D. Rogers, and D. M. Weldon 1973 21 p refs Presented at Symp. on Technol. of Controlled Thermonucl. Fusion Expt. and the Eng. Aspects of Fusion Reactors, Austin, Tex., 20 Nov. 1973 Sponsored by AEC

(LA-UR-73-910; Conf-731102-1) Avail: NTIS HC \$3.25
 A program is presently under way at Los Alamos to determine how superconducting magnetic energy storage in conjunction with normal-going superconducting switches can be made to deliver the energies of the order of 200 MJ that will be needed for plasma compression in a pulsed theta-pinch scientific feasibility experiment. After a review of the circuit configurations, the properties of commercially available and of some developmental superconductors relevant to both the energy storage coil and to the switch are discussed. Critical current densities at low fields and stability requirements both with respect to rapidly changing external fields and to self fields are of particular importance in determining optimum operating fields and temperatures. The tradeoff between eddy current losses in the stabilizing material and the need for coil protection if a coil normalcy should occur is described. Problems in potting or other forms of mechanical stabilization for both superconducting elements are pointed out.

Author (NSA)

N73-19042 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Stuttgart (West Germany). Inst. fuer Energiewandlung und Elektrische Antriebe.

RESEARCH ON CRYOGENICS AND INDUCTIVE ENERGY STORAGE AT THE DFVLR

C. Carpentis. In AGARD Energetics for Aircraft Auxiliary Power systems. Feb. 1972. 7 p refs (For availability see N73-19030 10-03)

The use of superconducting coils for energy storage is discussed. The objective was to find the optimizing parameters and to define the problems which involve the technical use of inductive energy storage. It was determined that: (1) the geometry of the coils is essential for optimal performance. (2) high critical current density rather than high critical field is important for optimal devices, and (3) the mass of the superconductor may be small as compared with the needed structural mass. The development of cryogenically cooled devices, particularly in the presence of time varying fields, is reported. Author

Author

N73-19043 Centre d'Etudes et Recherches de la Compagnie Electro-Mecanique, Le Bourget (France). Groupe d'Etudes Cryotechniques.

NONRADIATING SUPERCONDUCTING COILS FOR ENERGY STORAGE

M. Gayte, B. Girard, and A. Malandain. In AGARD Energetics for Aircraft Auxiliary Power Systems. Feb. 1972. 6 p refs (For availability see N73-19030 10-03)

The characteristics of superconducting coils as energy storage elements are investigated together with the main problems affecting their design: electromagnetic forces, energy radiation and discharge losses.

HD 9540.4, I5 1973

(LA-UR-73-73) MAGNETIC ENERGY STORAGE AND ITS APPLICATION IN ELECTRIC POWER SYSTEMS. Hassenzahl, W. V.; Rogers, J. D.; McDonald, T. E. (Los Alamos Scientific Lab., N. Mex.). 1972. 13p. (CONF-730306-2). Dep. NTIS.

From International convention and exhibition of the IEEE meeting, New York, New York, USA (26 Mar 1973).

The large capital expense of central power stations, such as coal-fired power plants, has led to the consideration of various types of energy storage for peak power shaving. Superconducting inductors with energy storage capacities of 1012 to 1013 J (the equivalent of 46 to 460 MW for a 6-h period) are discussed as an advanced energy storage system. Possible inductor configurations and their relative advantages are described. Preliminary estimates of capital and operating costs are given. (auth)

A73-11828 Superconducting considerations in rotating electrical machines. Z. J. J. Stekly (Magnetic Corporation of America, Cambridge, Mass.). In: Applied Superconductivity Conference, 5th, Annapolis, Md., May 1-3, 1972, Proceedings. (A73-11826 02-26) New York, Institute of Electrical and Electronics Engineers, Inc., 1972, p. 47-56. 14 refs. USAF-supported research.

This paper deals with the problems associated with superconducting field windings. The basic requirements for the field are discussed in terms of size, magnetic energy stored, power level, speed of rotation, number of poles. While the field winding is basically dc in nature, it is exposed to time varying magnetic fields and forces due to the armature currents generated by loading transients, faults, unbalanced electrical loads, as well as load generated harmonics. The effect of these on the design of the field as well as on the performance of the superconductor is discussed. (Author)

(Author)

A73-11831 Model coil test results for a pulsed superconducting magnet energy storage system. E. J. Lucas, W. F. B. Punchard, R. J. Thome (Magnetic Corporation of America, Cambridge, Mass.), R. L. Verga, and J. M. Turner (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio). In: Applied Superconductivity Conference, 5th, Annapolis, Md., May 1-3, 1972, Proceedings. (A73-11826 02-26) New York, Institute of Electrical and Electronics Engineers, Inc., 1972, p. 102-109. Contract No. F33615-71-C-1454.

A review is given of the design specifications for a 100,000 Joule system and the test results obtained on two model coils having energy storage capabilities of 500 Joules each. The energy storage coils that are being considered must be charged in a fraction of a second and discharged in a fraction of a millisecond. The losses are calculated on two models. Both assume that the coil remains superconducting during the charge period. However, on discharge one model assumes that the coil goes normal and one that it remains superconducting. In both models the losses during the charge period are considered to be the superconductor magnetization losses and eddy current losses in the normal substrate. (Author)

(Author)

N73-12816# Los Alamos Scientific Lab., N.Mex. SUPERCONDUCTING MAGNETIC ENERGY STORAGE AND TRANSFER. Also A73-11830

H. L. Laquer and J. D. G. Lindsay. 1972. 7 p refs. Presented at Appl. Superconductivity Meeting, Annapolis, 1 May 1972. Sponsored by AEC.

(LA-DC-72-470; CONF-720513-2) Avail: NTIS

Model experiments show that energy transfer at millisecond times from a superconducting storage coil into resistive loads can be achieved with a normal-going superconducting switch. It is planned to extend these studies to 300-kJ and 6-MJ systems, as well as to transformer-coupled inductive loads.

Author (NSA)

N71-23515*# Translation Consultants, Ltd., Arlington, Va.

ENERGY STORAGE CAPABILITIES OF SUPERCONDUCTORS IN VIEW OF HIGH POWER DISCHARGE [STOCKAGE D'ENERGIE POSSIBILITES DES SUPRACONDUCTEURS EN VUE DES DECHARGES DE GRAND PUISSANCES]

J. Sole Washington NASA Apr. 1971 25 p refs Transl. into ENGLISH of CEA, Saclay, France report CEA-R-3243 (Contract NASw-2038)

(NASA-TT-F-13585; CEA-R-3243) Avail: NTIS CSCL 10C

The energy storage capabilities of superconductors and the associated energy release at high power is discussed. A parallel and comparison is drawn between existing energy storage mechanisms (condensers, rotating machines, reactors, batteries, explosives) and the so called superconductors as seen from French experimental results. Direct comparisons are drawn by using material evaluations, performance equations and cost price ratios.

Author

N71-28888*# National Aeronautics and Space Administration, Washington, D.C.

THE USE OF SUPERCONDUCTORS FOR STORAGE AND DISCHARGE OF ELECTRICAL ENERGY [L'UTILISATION DES SUPRACONDUCTEURS POUR LE STOCKAGE ET LA DECHARGE DE L'ENERGIE ELECTRIQUE]

J. Sole Jul. 1971 137 p refs Transl. into ENGLISH from French report CEA-R-3515.

(NASA-TT-F-13559; CEA-R-3515) Avail: NTIS CSCL 20L

The principle of storage and liberation of energy is presented in its elementary form. A more detailed analysis of the successive charging, trapping storage, and discharge operations shows up the different aspects of the problem, and is followed by a review of the research published so far on this subject. The use of superconductors for application to the storage and discharge of electrical energy is proposed.

E.M.C.

N73-19041 Commissariat a l'Energie Atomique, Saclay (France). ENERGY STORAGE AND DISCHARGE BY SUPERCONDUCTORS [STOCKAGE ET DECHARGE D'ENERGIE AU MOYEN DU SUPRACONDUCTEURS]

P. Genevey, G. Prost, J. Sole, and B. Girard In AGARD Energetics for Aircraft Auxiliary Power Systems Jan. 1971 8 p refs In FRENCH (For availability see N73-19030 10-03)

After an examination of the principles of electric energy storage and discharge, a detailed analysis was made of load operations, trapping, and different problems raised about storage and discharge. The effects of load operation on the utilization of high flux pumping and the discharge that is released by means of rapid transition superconductor commutators are also analyzed. Experimental results are included.

Transl. by E.H.W.

N71-38448# Joint Publications Research Service, Washington, D.C.

DISCHARGE OF A SUPERCONDUCTING ACCUMULATOR INTO AN INVERTED CONVERTER
V. V. Andrianov et al 14 Sep. 1971 6 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR (Moscow), v. 198, no. 2, 1971 p 320-323

(JPRS-54051) Avail: NTIS

The use of superconducting inductive energy accumulators as standby electrical energy sources, as energy sources for load factoring in power systems, and as sources for powerful electrical pulses is discussed. An inverted converter is proposed as a means of transferring the superconducting accumulator's energy into an electrical system.

J.G.M.

N72-17829# Los Alamos Scientific Lab., N.Mex. ENERGY STORAGE AND SWITCHING WITH SUPERCONDUCTORS

H. L. Laquer and F. L. Ribe 1971 3 p Presented at the Intern. Working Session on Fusion Reactor Technol. Conf., Oak Ridge, Tenn., 1 Jul. 1971

(LA-DC-12990) Avail: NTIS

Inductive magnetic energy storage with superconductors or cryogenic aluminum conductors is discussed in regard to its use in providing the magnetic fields needed in pulsed thermonuclear reactors and in some large-scale pulsed plasma physics experiments designed to demonstrate the scientific feasibility of controlled fusion.

NSA

N71-11924# McElroy (Ralph) Co., Austin, Tex. Custom Div. STUDY AND CONSTRUCTION OF AN ENERGY-STORED SUPERCONDUCTING COIL

B. Girard et al [1970] 6 p Transl. into ENGLISH from Bull. Inst. Intern. Froid, Annexe (Paris), no. 1, 1969 p 419-423 Prepared for Los Alamos Scientific Lab.

(LA-TR-70-11) Avail: NTIS

A superconducting coil used to store energy and restore it in about one millisecond is described. Specially studied is the problem of current interruption. The coil was made from Nb-Ti stranded cable stabilized with pure aluminum. Its maximum energy content is approximately equal to 20 kJ and it is closely coupled with an aluminum ribbon coil that takes the place of the secondary of a non-iron transformer. The current is rapidly discharged by opening the circuit via a vacuum switch using an artificial zero-current injection system. This switch can break 1,000 A. without failure, with overvoltages of 4000 o 5000 V. It is capable of withstanding even higher voltages. The switching time is only a few microseconds. The stabilized superconducting coil withstood many charge rates of a few tenths of seconds duration and discharge rates of 3 or 4 milliseconds. Transfer energy rating is about 65% At the moment, a part of the coil energy is being lost through induced currents being dissipated through the metal walls of the cryostat.

Author (NSA)

**N71-11913# McElroy (Ralph) Co., Austin, Tex. Custom Div.
ENERGY STORAGE IN A SUPERCONDUCTING WINDING
[STOCKAGE D'ENERGIE DANS UN ENROULEMENT
SUPRACONDUCTEUR]**

M. Ferrier [1969] 11 p refs Transl. into ENGLISH from Bull.
Inst. Int. Froid, Annexe (France), no. 1, 1969 p 425-432
Sponsored in part by AEC Prepared for Los Alamos Scientific Lab.
(LA-tr-70-9) Avail: NTIS

The problems of energy storage on the scale of the fluctuations
of the national or regional load, i.e., of the order of 1,000 MWh
are examined. Various configurations are reviewed, and the short
solenoid of circular cross section is selected as being economically
the most favorable. The field produced and the distribution of the
mechanical constraints are discussed for this configuration. An
examination of the various losses (at the surface of the cryostat, by
mechanical or magnetic hysteresis) shows that they are acceptable.
The circulation of the cryogenic fluid is discussed in detail, and it
is shown that the ratio of stabilizing material to superconducting
material can be reduced to 10:1. Finally, the modes of connecting
the storage device to the grid are examined and there is a
discussion of the optimum size of the installation as a function of
the financial benefits that can be attributed to the different services
provided by the device.

Author (NSA)

B. TRANSMISSION

(ORNL-TM-4476) CRYOGENIC POWER TRANSMISSION TECHNOLOGY: CRYOGENIC DIELECTRICS. Quarterly Report, October 1 - December 31, 1973. (Oak Ridge National Lab., Tenn. (USA)). Feb 1974. Contract W-7405-eng-26. 29p. Dep. NTIS \$3.50.

The principal accomplishments reported include technical improvements to the intermediate voltage cryostat, improvements in the test procedure, and the achievement of more reliable breakdown values of liquid helium at atmospheric pressure obtained with gap widths between 0.25 and 3.0 mm. A change of the voltage ramp rates between 0.08 kV/sec and 10.0 kV/sec showed no significant influence on the breakdown values. Due to improvements in the cryostat design, only slow boiling was observed in the helium. Consequently, appropriate statistical evaluation of the breakdown values (considering the relatively small numbers, 12 to 150, obtained with each gap width) showed that the new measurements agree well with measurements of other investigators with externally refrigerated nonboiling helium and are significantly higher than published breakdown values for boiling helium. The experiments were performed with the intermediate voltage cryostat. Several subassemblies of the high-voltage cryostat have been completed. (auth)

(ORNL-TM-4433) CRYOGENIC POWER TRANSMISSION TECHNOLOGY: CRYOGENIC DIELECTRICS. Quarterly Report, July 1 - September 30, 1973. (Oak Ridge National Lab., Tenn. (USA)). Jan 1974. Contract W-7405-eng-26. 16p. Dep. NTIS \$3.00.

An investigation of the dielectric properties of fluids and solids for use in superconducting systems is underway at the Oak Ridge National Laboratory as part of the AEC program in superconducting power transmission. The investigation initially will encompass ac and dc breakdown and pre-breakdown phenomena in liquid helium and in a variety of solids in liquid helium. Extension to impulse measurements is expected in the near future. A prime objective of the investigation is to determine scaling laws applicable to various models of superconducting cables and other cryogenic apparatus. The experiments are being devised with this objective in mind. Experimental facilities have been set up for ac testing with a series resonant transformer to 700 kV rms and for dc testing to 600 kV. A high-voltage cryostat has been designed for service to 1000 kV with provision for optical as well as electrical recording of both breakdown and pre-breakdown phenomena. Other apparatus for testing to lower voltages is also available. Instrumentation for partial discharge measurements by multichannel pulse height analysis, high speed oscilloscope, and bridge detection are available. The influence of electrode surfaces and impurities as well as pressure and temperature on the dielectric properties of liquid helium will be determined. The behavior at large gaps is of particular interest. Breakdown and surface flashover of bulk and laminated solids in liquid helium and in vacuum at liquid helium temperatures are to be included in the investigations. (auth)

Energy and Superconductivity.
National Bureau of Standards, Boulder, Colo. Cryogenic Data Center. 20 Mar 74. 36p B-1153
COM-74-10713/7WE PC\$7.00/MF\$7.00

Contents: Generators, motors, transmission lines, transformers, thermonuclear fusion, MHD, magnets, miscellaneous applications, refrigeration, patents, and reviews.

UHV OR HVDC. That is the Question. Jeffs, E.; Colling, N. Energy Int.; 11: No. 1, 9-12(Jan 1974).

The merits of hvdc and uhv ac transmission systems were discussed at an international conference of Electrical Engineers in London, Nov. 1973. Environmental aspects are discussed in relation to increased power-transmission ratings. Within the next decades, power generation will be concentrated in huge blocks of power between 10 to 20 GW in size, and transmission rights-of-way will be restricted. What the transformer has done for ac distribution the solid state rectifier might do for dc transmission. The stability criterion on an interconnected system, the use of shunt capacitors and saturable reactors, the possibilities of superconducting cables, and uhv are discussed. Economic aspects of future power transmission systems are outlined. (MCW)

A74-22247 Low-loss niobium-tin compound for superconducting alternating-current power transmission applications. M. Suenaga and M. Garber (Brookhaven National Laboratory, Upton, N.Y.). Science, vol. 183, Mar. 8, 1974, p. 952-954. 19 refs. AEC-NSF-sponsored research.

A Nb₃Sn superconductor has been fabricated in rods and tapes by the interaction of the tin contained in a copper-tin alloy with niobium which had been in contact with the alloy material. This conductor has lower alternating-current (60 hertz) losses than any presently available commercial products. (Author)

USAEC-DAT DC Superconducting Power Transmission Line
Project at LASL, October 1 Through December 31, 1973.

W. E. Keller, and R. D. Taylor.
Los Alamos Scientific Lab., N. Mex. Apr 74, 20p
LA-5581-PR PCS4.00/MF\$1.45

Short sample critical current tests of multiple Nb₃Sn commercial tapes arranged on a copper support tube are reported: at 4 K nearly 30,000 A has been carried by one sample. Critical current testing of short samples in the liquid hydrogen temperature range, 13.9 to 20 K, has been initiated and some results are given. The 20-m test bed has been successfully operated at 4000 A with a liquid helium cooled NbTi superconductor. Preliminary considerations for some new small diameter line configuration concepts are presented.

SUPERCONDUCTIVITY: LARGE-SCALE APPLICATIONS.

R.A. Hein.

Science, v.185, no.4147, July 19, 1974, p.211-222.

This article is an overview of areas involving large-scale applications of superconductivity for which the 1970's are a decade of critical decision. Applications to superconducting solenoids, high-energy physics, electric power transmission, rotating electrical machinery, energy storage and transfer, and superconducting magnets for superfast trains.

(LA-UR-73-1500) DEVELOPMENT PROJECT FOR A DC SUPERCONDUCTING POWER TRANSMISSION LINE.

McDonald, T. E. (Los Alamos Scientific Lab., N. Mex. (USA)). 1973. 9p. (CONF-740410-1). Dep. NTIS \$4.00.

From underground transmission and distribution conference; Dallas, Texas, USA (Apr 1974).

A dc superconducting power transmission project that is in progress at the Los Alamos Scientific Laboratory is described. The project is directed toward the development of a system that would primarily be used for long-distance high-capacity transmission. A discussion of the advantages of a dc superconducting transmission line is given and preliminary cost estimates of a conceptual design are presented. (auth)

U.S. Federal Power Commission. Task Force on Energy Distribution Research. ENERGY DISTRIBUTION RESEARCH; RESEARCH AND DEVELOPMENT PROGRAMS FOR 1975-1994. Recommendations of the Task Force on Energy Distribution Research, Technical Advisory Committee on Research and Development, consultants to the Task Force Supported by the National Science Foundation, Washington, D.C. Chairman of the Task Force: Robert A. Bell. Program Director for the consultants: James Nicol. Cambridge, Mass., Arthur D. Little, 1973. 1 vol. (various pagings)

(LA-UR-73-1323) LABORATORY TEST APPARATUS FOR A SUPERCONDUCTING DC TRANSMISSION LINE. McDonald, T. E.; Kerr, E. C.; Trella, W. J. (Los Alamos Scientific Lab., N. Mex. (USA)). 1973. 5p. (CONF-740108-1). Dep. NTIS \$3.00.

From winter power meeting; New York, New York, USA (27 Jan 1974).

The Los Alamos Scientific Laboratory has recently initiated a program to study the technical and economic feasibility of a dc superconducting power transmission line. As part of the program, a large sample testing apparatus has been constructed consisting of a test bed that is approximately 10 m long and can hold a 20 m sample in a race track arrangement; high current potheads that go from room temperature to cryogenic temperature; and a high current source. The test bed and associated apparatus and a summary of the test procedures to be used are described. (auth)

Superconducting Power Transmission Exchange. Report of the United States Team's Visit to the Soviet Union, October 9-October 21, 1973.

Brian C. Balenger.
Atomic Energy Commission, Washington, D.C. 1973. 50p
WASH-1305 PCS4.00/MF\$1.45

Contents:

Delegation membership.

Itinerary:

Institutions visited and their programs;

The U.S.S.R. superconducting cable program;

Cryogenic dielectrics research in the U.S.S.R.;

European visits.

N74-19378#

(LA-5271-PR) USAEC-DAT de SUPERCONDUCTING POWER TRANSMISSION LINE PROJECT AT LASL. Progress Report, November 1, 1972-March 1, 1973. Bartlett, R. J.; Hoffer, J. K.; Keller, W. E.; Kerr, E. C.; McDonald, T. E.; Taylor, R. D.; Trella, W. J.; Giorgi, A. L.; Dickinson, J. M. (Los Alamos Scientific Lab., N. Mex. (USA)). May 1973. Contract W-7405-eng-36. 76p. Dep. NTIS \$6.00.

The aims of the SPTL project include a demonstration that incorporation of dc superconducting transmission lines into the present US electrical utility power system is not only feasible but would lead to capital and operating economies compared with either conventional cable systems or superconducting ac lines, wherever large blocks of power are to be transmitted over long distances. The impact on the environment is minimal. The demonstration model is a line 1000 km long capable of carrying 5 GW of power, the type useful for carrying power from the Four Corners production complex to large urban areas in Phoenix, San Diego, or Los Angeles. The experiment includes data on superconducting samples, critical current measurements, test bed parameters, and power engineering studies. Experimental progress and planning are reported. (MCW)

(WASH-1281-4) ENERGY TRANSPORTATION, DISTRIBUTION, AND STORAGE. Subpanel Report IV Used in Preparing the AEC Chairman's Report to the President. (USAEC, Washington, D. C.). 1973. 158p. Dep. NTIS \$11.00.

Five year R and D program objectives in transportation and distribution are: (1) continue development of increased-capacity ac and dc overhead power transmission systems by doubling the present capacity by 1985, and achieving a multiplication of 4 to 10 times by the year 2000; (2) to continue the development of reliable and lower-cost underground transmission systems capable of matching future overhead systems in both power capacity and voltage; (3) to develop advanced methods and equipment for systems security and control that will improve reliability and efficiency of generation, transmission, and distribution; and (4) to analyze electrical energy transportation systems development in order to identify the more desirable growth options. and to pursue fundamental investigations that have potential for long-term (beyond 2000 AD) application. Five-year objectives in the area of energy storage are: (1) to support completion of bench models of Na/S and Li/S batteries; (2) to support completion of a 10-mwh pilot model of an advanced battery (Na/S or Li/S); (3) to provide surveillance of Zn/Cl₂ battery development and support fundamental research in electrochemistry; to provide engineering development of superconducting energy storage magnets and flywheels; and to provide for economic assessment of batteries and other storage systems. (auth)

(LA-5361-PR) USAEC-DAT de SUPERCONDUCTING POWER TRANSMISSION LINE PROJECT AT LASL. Progress Report, March 1-June 30, 1973. Keller, W. E.; Taylor, R. D. (Comps.) (Los Alamos Scientific Lab., N. Mex.). Aug 1973. Contract W-7405-eng-36. 24p. Dep. NTIS \$4.00.

Progress is described in the areas of superconducting materials development, fabrication, and characterization; superconducting cable test-bed construction and instrumentation; and specifications for electrical power system studies incorporating dc superconducting transmission lines. (auth)

TITLE: Power Over People
AUTHOR: Young, L. N.
CORPORATE AUTHOR: American Foundation for Continuing Education; Open Lands Project
ADDRESS: Open Lands Project, Chicago, IL
PUBLICATION DESCRIPTION: Oxford University Press Inc., New York, 216 p.

PUBLICATION DATE: 1973
ABSTRACT: Using illustrations from a case history in Ohio, the actual and potential environmental dangers from the erection of a 75-kv transmission line are detailed. The electric utilities are accused of abuse of power, in that they seek to maximize financial profit at the expense of human welfare and rights. This is especially true in rural areas. The particular hazards associated with this ultra high voltage line are emphasized. (JNC)
AVAILABILITY: Publisher or bookstores (\$7.50)

1973

SUPERCONDUCTING HIGH POWER THREE-PHASE AC CABLES. Bogner, G. (Siemens AG, Erlangen, Ger.). Kern-technik, 15: No. 8, 358-365(1973). (In German and English).

The makeup of a superconducting three-phase ac cable with coaxial conductor pairs is described. Thermal insulation can be ensured by means of techniques already used in the construction of containers for liquids with low boiling points. Suitable superconductor materials are niobium and niobium-tin. The most effective electric insulation is achieved with a multilayer tape winding of nonpolar plastics. The cable is cooled by two separate cycles operated with liquid nitrogen and liquid helium, both under a raised pressure. Distances of 10 km between cooling stations are possible. Comparisons with other novel high-power underground transmission systems indicate that the superconducting three-phase ac cable will probably be the most economic solution for the power ratings of about 2000 MW and over. (GD)

FUTURE TRANSMISSION - UNDERGROUND?

A.F. Corry and E. Kasum.

IEEE Trans. Power App. & Syst., v.PAS-92, 1973, p.520-

Abstract: Future transmission systems will handle larger blocks of power and a greater percentage will be installed underground. Solutions to the present limitations on operating such systems are being developed and it is anticipated that the economies of size will reduce the competitive disadvantage. It is important that continued effort be directed in this field so that the necessary systems are developed.

1973

1973

CONSTRUCTION AND UTILIZATION OF CRYOGENIC CABLES IN ELECTROENERGETIC SYSTEMS AND NETWORKS. Cruceru, C. *Electrotehnica* (Bucharest); 21: No. 12, 458-464 (Dec 1973). (In Rumanian).

The building and utilization of cryogenic cables in high and very high voltage networks are presented and the constructive elements of such cables are described showing the technical and economic advantages they offer. The technical importance of cryogenic cables, some recent achievements in the world, and the prospects of their use in Romania are presented. (auth)

FREQUENCY RESPONSE OF A SUPERCONDUCTING TRANSMISSION LINE. Campbell, C. K. (McMaster Univ., Hamilton, Ont.). *Proc. IEEE* (Inst. Elec. Electron. Eng.); 61: No. 6, 799-806 (Jun 1973).

A two-element equivalent circuit for the surface impedance of a superconductor is considered in approximations of the frequency response of a superconducting transmission line. It is shown that the model yields good approximate agreement with more rigorous derivations applied to classical or anomalous normal conductivities, as well as to nonlocal conduction effects. (auth)

TITLE: Power Plants, Transmission Lines, and the North American Environment

AUTHOR: Burgess, R. L.

CORPORATE AUTHOR: Oak Ridge National Laboratory, Environmental Sciences Division 37810

ADDRESS: P.O. Box 1, Oak Ridge, TN 37810

PUBLICATION DESCRIPTION: Paper presented at a symposium, Preparing Environmental Reports for Nuclear Power Plants, in Monterey, California, January 22-24, 1973, 20 p.

PUBLICATION DATE: 1973

SPONSOR: Eastern Deciduous Forest Biome, US-IBP: National Science Foundation

ABSTRACT: Although such attention is currently being given to environmental effects in the location of new power plant construction, very little is devoted to the effects of the associated transmission lines. The right-of-way required for most plant output far exceeds the land area of the plant itself. Careful planning of routes, using available vegetation maps, could do much to assuage the environmental damage. (JMC)

(AEC-tr-7509) PROBLEMS ON DEVELOPMENT OF SUPERCONDUCTING POWER TRANSMISSION LINES. Rendik, N. T.; Blinkov, E. L. (ed.). (USAE Technical Information Center, Oak Ridge, Tenn.). 1973. Translation of Problemy sozdaniya i razvitiya superprovodnykh liniy, 1973, Moscow. 36p. Dep. NTIS \$4.00.

The six articles included here relate to problems facing the developers of superconducting power transmission lines and their solution, namely: (1) theoretical and experimental investigations related to analysis of electromagnetic, thermophysical, and hydrodynamic processes that take place in power transmission lines; (2) cryogenic high-voltage insulation, basic requirements on insulation constructions, the types of cryogenic insulation, the advantages of coolant and vacuum as the basic insulation, and the scientific research program on high-voltage insulation; (3) investigation of properties of superconducting ac cable (SCC) lines that are largely determined by their transmitting capacity; (4) features of heat exchange and hydrodynamics of SCC that are associated with the fact that the range of working parameters of the basic coolant of SCC is the near-critical range; (5) character of pulsation modes and conditions under which they occur in choice of working parameters of the coolant; and (6) in developing superconducting cables, the problems of measuring the parameters of SCC, automation of measurements, and control, regulation, and safety. (MCW)

UHV POWER LINES CAN BE BUILT NOW. Deabrock, F.; Shah, K. R. *Energy Int.*; 10: No. 12, 19-21 (Dec 1973).

American utilities are preparing for voltages up to 1500 kV to meet the demand for bulk energy transfer. Power transmission at the uhv is feasible and the technology for designing line, equipment, and substations for these levels is available. Aesthetically acceptable structures can be designed to minimize the impact of the line on the environment. Electrical radiation criteria, the National Electric Safety Code, switching surge flashovers, and heavy mechanical loadings will be used to optimize uhv transmission-line design parameters so as to minimize radio and television interference, ozone generation, audible noise emission, and induced voltages on nearby structures. (MCW)

RESEARCH ON UHV TRANSMISSION NEARS COMPLETION OF SINGLE-PHASE TESTING AT 1000 TO 1500 KV. EEI (Edison Elec. Inst.) Bull.; 41: No. 4, 190-192 (1973).

Bundles of 4, 6, 8, 10, and 12 conductors were tested, using a single-phase overhead test line energized by means of a single-phase bus, which includes a 1500-Kv single-phase 33-Mva autotransformer, a lightning arrester, a precision SF₆-insulated capacitor, and a coupling capacitor for radio-noise measurements. The test line was energized in March 1970 and was used to determine line corona performance of many different bundle conductors. Audible noise, radio noise, and corona loss were measured under varying weather conditions. Two test cages were used for investigations of audible noise, radio noise, corona loss for different conductor bundle configurations, and conductor bundles for voltages up to 1500 Kv. Proposals are made for line performance measurements on a three-phase basis from 1974 to 1976. (MCW)

(BNL-17894) PREDICTED CHARACTERISTICS OF SUPERCONDUCTING TRANSMISSION CABLES. Forsyth, E. B. (Brookhaven National Lab., Upton, N.Y. (USA)). [nd]. 7p. (CONF-731107-1). Dep. NTIS \$3.00.

From conference on high voltage DC and/or AC power transmission; London, UK (19 Nov 1973).

A self-contained superconducting cable is under development in West Germany. Superconducting versions of both compressed gas-insulated and pipe-type cables are being investigated in the US. Basic measurements have been made of the properties of the conductor and insulating materials and of helium for cable cooling systems. Based on this information, it has been shown that superconducting ac cables possess very desirable electrical characteristics. Impedance matching to existing multiple circuit overhead installations operating between 1 to 3 times SIL should be possible. This is an attribute shared by no other underground cable technology. Performance of these cables under fault conditions is hard to predict without further experimental work. The overload characteristics will be superior to conventional cables. All cost estimates are tentative, but based on the ones that have been made ac superconducting cables may become economically attractive above 2 GVA. Superconducting dc cables appear to be a feasible extension of ac cable design, but the great distances necessary for economic optimization will probably preclude an early application unless converter costs are drastically reduced. Many technical problems have to be solved before viable superconducting cables can be presented to the system planners. The design of low cost, reliable and long-life cryostats is a formidable problem. There is a dearth of information on dielectric behavior at cryogenic temperatures, particularly on a long-term degradation. (auth)

(JUL-938-TP) ENERGY TRANSMISSION BY MEANS OF CRYOCABLES. Bräbder, H.; Diering, K.; Fischer, W.; Heller, L.; Hofmann, A.; Komarek, P.; Kuhn, E.; Leeching, H. W.; Raquin, W.; Zimmermann, E. (Kernforschungsanlage, Juelich (West Germany)). Institut fuer Technische Physik. Mar 1973. 251p. (In German). Dep. NTIS (U. S. Sales Only) \$14.75.

Six kinds of electrical insulations, three variations of the flow of the cooling medium, two possibilities for the arrangement of electrical and thermal insulation, and some kinds of conductor constructions are discussed. The justification of the use of a cryocable depends on the construction of the cable, on the materials that are used, and on the cooling machinery. For economic reasons, aluminum or copper will be the preferred material for the conductors. The cooling liquid can only be liquid nitrogen. The costs take into account the capital cost of the cable, termination and fitting costs, including installation, civil engineering, cooling stations, and costs of power losses, i.e., the costs for the electrical losses in the cable and the energy costs for the cooling stations. Advantages for the justification of the development of cryocables are that the width of the cable trench related to the power rating is considerably less when compared with conventional cables; by stepwise uprating of the installed cooling stations, the transmission capability can be adapted to the growing demand; a multiplication of the transmission capability is possible if more cooling stations are installed along the line; and even operating at the maximum continuous load, a cryocable can sustain a substantially higher short-time overload compared to a conventional cable because of its high heat capacity. (MCW)

(JUL-954-TP) POWER TRANSMISSION WITH LOW-TEMPERATURE NORMAL-CONDUCTING CABLES. Optimization Problem and Cost Structure. Heller, L.; Hofmann, A. (Kernforschungsanlage Juelich G.m.b.H. (F.R. Germany)). Inst. fuer Technische Physik. May 1973. 73p. (In German). Dep. NTIS (U.S. Sales Only) \$5.75.

An economic comparison was made between the investigated types of a cryocable and an advanced normal-temperature-cable, i.e., an artificially cooled SF₆ cable. As this is done on a uniform basis, the result will surely have a high reliability. The comparison shows that the LN₂-vacuum-tube cable is not competitive with the advanced SF₆-tube cable within the whole region of power investigated. The LN₂-litz-conductor cable on the other hand is able to compete with power and length are high. This is especially true if it can be shown that the estimation of the fabrication costs of the conductor were too pessimistic. Experimental research on losses and fabrication problems of litz conductors with high cross sections are very important and will be decisive for cryocable development. (27 figures, 35 references) (auth)

ELECTRICAL TRANSMISSION OF ENERGY: CURRENT TRENDS. Howard, P. R. (Central Electricity Generating Board, Gelliford, Eng.). Energy Policy; 1: No. 2, 154-160 (Sep 1973).

The trend towards ultrahigh voltages in the 1000 to 1500 kv range involves new technological and environmental problems. Technically, there is no difficulty in constructing lines and substations at voltages up to 1500 kv or higher, but the economic, environmental, and aesthetic parameters must be considered. Underground cables cost 20 times more than overhead lines. Existing electrical transmission systems and future systems necessary are discussed for the UK, the European countries, and North America. (MCW)

THYRISTOR VALVE IN HVDC TRANSMISSION. Keady, G.; Gileig, T. (Hydro-Quebec Inst. of Research). IEEE (Inst. Elec. Electron. Eng.) Spectrum; 10: No. 12, 36-43 (Dec 1973).

The application of thyristor valves rather than mercury-arc valves for rectification in high-voltage dc transmission systems has increased. Schemes in service include Eel River in New Brunswick, Canada, the Gotland extension in Sweden, and the Sakuma extension in Japan. Basic circuits, design, construction, and operation methods are discussed for the use of thyristor valves in HVDC transmission. (MCW)

FLEXIBLE SUPERCONDUCTING POWER CABLES.

E.B. Forsyth, et al.

IEEE Trans. Power App. & Syst., v.PAS-92, 1973, p.494-

In view of the fact that installation costs may represent up to half the investment in an underground cable system, it is desirable to develop concepts for superconducting cables which, from the beginning, promise to keep this expense to a minimum. Superconducting cable will be very light and, providing it is flexible, the cable should be capable of being pulled in long lengths. Two concepts for flexible superconducting cables are presented together with a discussion of expected performance in the system.

HVDC STATIONS FOR POWER INFED FROM POWER STATIONS WITH GENERATOR AND STATIC CONVERTOR IN UNIT CONNECTION. Kaeferle, J. Brown Boveri Rev., 60: No. 8, 206-211(May 1973).

In cases where a power station feeds an HVDC station direct and exclusively, certain economic and technical advantages are presented as regards the complete system, i.e., power station and HVDC station, by dispensing with the three-phase busbar system and arranging the static converters in unit connection with the generators. The features of such an arrangement are discussed. (auth)

SUPERCONDUCTING POWER TRANSMISSION: COOL SOLUTION TO A HOT PROBLEM.

R.W. Meyerhoff.

Cryogenics & Industrial Gases, July/Aug.1973, p.19-23.

Underground superconducting transmission holds greatest promise for mid-'80's power transmission requirements, research studies show.

TITLE: An Approach to the Power Shortage Problem: Optimal Allocation of Existing Excess Reserves Through Interregional Transmission

AUTHOR: Moses, M.A.

CORPORATE AUTHOR: University of Philadelphia, National Center for Energy Management and Power

ADDRESS: Philadelphia, PA 19104

PUBLICATION DESCRIPTION: Report No.

WSP/RANW/SE/GT29729/TR/73/2, 50 p.

PUBLICATION DATE: 1973, August 1

SPONSOR: National Science Foundation, RANW Program

ABSTRACT: A coordinated national grid system should lessen or eliminate the energy shortage. This idea relies inherently on the presence of what can be termed "staggered peak loads" as we traverse time zones from the East Coast to the West. That is, when the New York City area experiences its peak demands between 12-2 P.M., the Los Angeles area is approximately three hours away from their peak. If L.A. could transfer electrical power to the east, the frequency of brown - or black-outs could be substantially decreased.----Our approach is not designed to minimize (or maybe a more appropriate word would be "conserve") the generation of electrical energy.----Our model attempts to work within the confines of existing capacity limits, and without decreasing demands.----What our model provides is the most efficient allocation and routes of distribution of electrical energy given the existing system capabilities. (auth, Abstract modified)

HVDC AT SQUARE BUTTE EXTENDS SOLID-STATE EXPERIENCE. Ryder, F. (New Brunswick Electric Power Commission, NJ); Marchetti, R.; Fink, J. L. Elec. Light Power, T/D Ed.; 51: No. 20, 50-51(Oct 1973).

The Square Butte project will be rated at ± 250 kV do 1000 amps. The 500-Mw system will interconnect the power generating complex Center, ND, near Bismarck, with Duluth, MI, a distance of 456 miles. The project is scheduled for commercial operation in May of 1977. Design work is now underway for the terminal equipment. The system will be bi-polar, with provision for metallic return in case of a prolonged outage of one pole. Fibers are provided so that one pole can be operated independently of the other, and valve groups are connected in the 12-pulse arrangement, thus minimizing harmonic generation and reducing the size of the required filters by nearly two to one. Comparisons are made with the Eel River asynchronous tie. Simplification at Square Butte eliminates synchronous condensers. Solid state valves are employed and do not require external damping circuits as in the case with mercury-arc. (MCW)

N74-19373# Oak Ridge National Lab., Tenn.
**CRYOGENIC DIELECTRICS AND SUPERCONDUCTING
 AND CRYOGENIC MATERIALS TECHNOLOGY FOR POWER
 TRANSMISSION** Annual Report, 1 Jul. 1973

Nov. 1973 150 p refs
 (Contract W-7405-eng-26)
 (ORNL-TM-4341) Avail: NTIS HC \$9.50

The principal effort in the dielectric program during this reporting period, March 1 to June 20, has been to install the 700 kV series resonant transformer so that high voltage ac testing can be accomplished. Provisions were made that this unit will share a test stand with the Haelely 600 kV dc power supply. Design and fabrication of a helium dewar with a 1000 kV bushing for use in this test stand has continued. The design of a cryostat for experiments with intermediate voltages was completed, and the assembling of this cryostat is under way. A small laboratory exploratory experiments with voltages up to 130 kV dc and 80 kV ac has been set up. A Biddle partial discharge detector has been ordered. A Faraday cage has been located which can provide a low interference laboratory for low level discharge measurements. Auxiliary investigations have been continued which are necessary for the design, construction, and operation of test equipment.

Author (NSA)

EXPERIENCE WITH THE AEP 765-kV SYSTEM.

II. System Performance... Mallszewski, R. M. (American Electric Power Service Corp., New York). IEEE (Inst. Elec. Electron. Eng.), Trans. Power App. Syst.; PAS-92: No. 4, 1337-1347(1973).

The system performance aspects of AEP's experience with its 765-kV transmission network are discussed. The first segment of this network was energized in May 1969. Since that time, a total of 670 miles of 765-kV transmission has been placed in operation. The experiences accumulated thus far with bringing segments of 765-kV transmission into service, as well as with real and reactive power flow, reactive compensation and supply, voltage control, and 765-kV equipment spare requirements are reviewed. (auth)

HVDC: VALID AID FOR A-C TRANSMISSION. Marks, J. A. (ed.). Elec. Light Power, T/D Ed.; 51: No. 20, 43-47(Oct 1973).

More dc projects will be commissioned in the future mainly due to the high value placed on the environment. Strides have been achieved in valve technology, in station size reduction, and in simplicity. The justifications for dc transmission are long distance, bulk transmission for economy; stabilizing links between pools; and high capacity underground links. A dc link can reliably mitigate ac transient disturbances that might ripple from one ac system to another. Dc by its nature limits growth of a system short circuit on duty, which is a bigger problem every day in densely loaded systems. Oscillating disturbances on large regional interconnections can be damped by programmed control of dc flow on a link between pools. Some new domestic applications of long-distance dc transmission are cited, namely, the Basin Electric Power Co-op of Bismarck, N. D.; Tri-State G & T Assoc. of Denver; Square Butte HVDC, the second to use solid state valves in North America; and the 1100-mile HVDC project in the Republic of Zaïre, central Africa. The problems facing dc breakers are for a method to drive current to zero under constant voltage, and for absorption of magnetic energy stored in the system. (MCW)

(SLA-73-207) HEAT TRANSMISSION BY HOT WATER THROUGH LONG PIPELINES. Thunborg, S. (Sandia Labs., Albuquerque, N. Mex.). Jun 1973. 15p. Dep. NTIS \$3.00.

The basic equations relating to the cost and effectiveness of transmitting heat over long distances through hot-water pipelines are derived. It gives an insight into the problems associated with hot-water heat transmission. Further, it applies these equations to a 200-mile pipeline and concludes that such a system is not yet cost effective in relation to today's fossil fuel prices. (auth)

N74-19374# Oak Ridge National Lab., Tenn. Thermonuclear Div.
DYNAMIC STABILIZATION OF Nb3Sn TAPE SUPERCONDUCTORS

K. Koyama and M. S. Lubell Oct. 1973 18 p refs
 (Contract W-7405-eng-26)
 (ORNL-TM-4391) Avail: NTIS HC \$3.00

The stabilization of Nb3Sn ribbon superconductor achieved by the interleaving of high conductivity aluminum has been experimentally investigated by observing the flux jumping on a rectangular stack placed in a changing transverse magnetic field. The results show that raising the conductivity of the aluminum leads to significantly increased stability as does increasing the thickness at fixed conductivity. The first flux jump field for both cases is given for various rates of increase of the applied transverse field. The limiting value at fast rates is compared to a new theory of dynamic stabilization recently proposed by one of the authors (KK) and found to agree well for the case where the interleaved aluminum is thermally insulated from the superconductor. Agreement is not good when the aluminum is partially contributing to the thermal diffusion in an undetermined amount.

OPTIMAL CONTROL OF A HVDC TRANSMISSION
 LINK. Sachdev, M. S.; Fleming, R. J.; Chand, J. (Univ. of Saskatchewan, Saskatoon). IEEE (Inst. Elec. Electron. Eng.), Trans. Power App. Syst.; PAS-92: No. 6, 1958-1965(1973).

The modern control theory is applied to design HVDC controllers. The state regulator and tracking techniques were used to design controller feedbacks to improve system performance. Both optimal and sub-optimal controllers were designed. An "eigenvalue search" technique was also applied to determine the desired controller gain and time constant. Using the various designed controllers, the dynamic performance of the system was studied on both a digital computer and a small scale simulator. Some of these time domain studies are included in addition to the root locus plots. (auth)

CN-140,171

TRANSMISSION LINE FAILURES. (Papers presented at the IEEE Power Engineering Society 1973 Summer Meeting and EHV/UHV Conference, July 20, 1973). 1973. 30p.

1973

Institute of Electrical

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Electronics Engineers, Power

Engineering Society

Conference on EHV/UHV

(Paper)

73CH0816-9-PWR

July 20,

1973

L-12-10-73

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Power transmission

CN-129,959,Atto.

ENERGY: A DIALOGUE. Norman Metzger, ed. (Contains a brief synopsis of the audiotapes entitled "Energy: A Dialogue". (1973).

(1973)

American Association for the Advancement of Science

Power sources

Power sources, Nuclear

Power transmission

Energy conservation
Public policy

197,223
L-9-21-73

TITLE: Progress Report, USAEC-CAT CC
Superconducting Power Transmission Line
Project at IASL, November 1, 1972 to March 1,
1973

AUTHOR: Bartlett, R.J.; Roffey, J.R.; Keller,
W.E.; Kerr, F.C.; McDonald, T.L.; Taylor,
R.D.; Trella, W.J.; Giorgi, A.I.; Dickinson,
J.E.

CORPORATE AUTHOR: Los Alamos Scientific Laboratory
ADDRESS: Los Alamos, NM 87544

PUBLICATION DESCRIPTION: Progress Report No.

LA-5271-PR, 72 p., 6 references

PUBLICATION DATE: 1973

SPONSOR: U.S. Atomic Energy Commission, Division
of Applied Technology

ABSTRACT: This progress report, covering the
period November 1972 through February 1973,
describes in detail the work carried out on
this project. It is divided into four
sections, superconducting samples, critical
current measurements, test bed, and power
engineering. An appendix gives a brief
outline of superconductivity. (JNC)

CRYOGENIC POWER CABLE: DESIGN AND TEST.

. B.C. Belanger and M.J. Jefferies.

Cryogenics and Industrial Gases, Mar./Apr.1972,
p.15,18-22.

Test program was designed to demonstrate
feasibility of prototype cryogenic power cable.

IS 'POWER TO THE PEOPLE' GOING UNDERGROUND.

G.D. Friedlander.

IEEE Spectrum, v.9, no.2, p.62-71, Feb.1972.

A report on an important conference regarding the
economic feasibility and technological progress
toward the construction of underground high-voltage
transmission lines.

TITLE: Federal Council for Science & Technology
R&D Goals Study, Report of Technical Group on
Electrical Transmission and Systems
CORPORATE AUTHOR: Federal Council for Science &
Technology

ADDRESS: 216 Executive Office Building,
Washington, DC 20506

PUBLICATION DESCRIPTION: 115 p. report

PUBLICATION DATE: 1972, July 14

SPONSOR: Executive Office of the President,
Office of Science & Technology

ABSTRACT: The Technical Group on Electrical
Transmission and Systems has examined areas
of technology within its purview which are of
major importance to the electrical power
industry if it is to meet its share of the
Nation's energy requirements. For
convenience, the Technical Group arranged
these topics under six subject headings, each
of which constitutes one of Chapters II
through VII of this report: UHV ac overhead
transmission; DC components and systems;
underground power transmission; microwave and
charged-particle transmission; multi-GV
transmission systems; and controls and
control systems. In selecting these topics
the Technical Group was guided by the
following criteria: eventual impact;
technical leverage (there must be a
possibility of major improvement through
technological advance); and requirement for
major R&D effort. The Technical Group
reviewed each of the six areas to determine
where R&D funds could be invested with
greatest benefit to the systems and
transmission aspects of the Nation's future

electrical energy problems. In its
investigations the Technical Group applied
the three general criteria listed previously.
Candidate programs were analyzed also to
determine their potential contribution to:
the long term reduction of the impacts of the
energy system on the environment; the
conservation of natural resources; and
improved economics. Each of the succeeding
chapters contains a review of the status of
the technology in question, of the technical
evolution to be expected in the future, and
of the areas in which R&D can make
significant improvements, as measured by the
criteria just mentioned. Each is concluded
with a summary containing several R&D
programs that are worthy of support. (auth.
Introduction modified)

(BNL-50384) WARM WATTS AND COOL CURRENTS:
POWER TRANSMISSION BY SUPERCONDUCTING CABLE.
Brookhaven Lecture Series Number 114. Forsyth, E. B. (Brook-
haven National Lab., Upton, N. Y.). 25 Oct 1972. Contract AT(30-
1)-16. 18p. Dep. NTIS \$4.00.

The need to build very large machines at BNL, such as the AGS,
has developed a strong capability in the field of power engineering.
In addition, a strenuous effort has been made since the early sixties
to develop practical superconducting magnets for accelerator ap-
plications. Thus it was natural to combine these areas of expertise
when the Laboratory was requested to perform a study of power
transmission by superconducting cable. During the course of this
study a careful examination was made of all technologies proposed
as solutions to the problem of transmitting very large blocks of
electricity one to two decades hence, particularly if overhead lines
are prohibited in urban areas. It was concluded that superconduct-
ing cables offered some potentially attractive features, although
many serious technical problems had to be solved. A develop-
ment program is in progress which includes the investigation of
many of these problems, particularly in the areas of cryogenic
engineering and materials suitable for carrying heavy currents
and high voltages at very low temperatures. (auth)

NEW CONCEPT IN ENERGY TRANSMISSION. Greg-
ory, Derek P. (Inst. of Gas Tech., Chicago). Pub. Util. Fortn.:
89. No. 3, 21-9/3 Feb 1972.

As the U. S. moves from a fossil fuel economy toward a nuclear
power age to meet burgeoning energy demands, the problems of
electricity transmission, distribution, and storage become ac-
centuated. An alternative exists to the growing number of over-
head power lines appearing around cities. Hydrogen is a synthetic
fuel that could be made from water and electricity at the power
stations and used as a means of underground energy transmission.
It is an ideal fuel in many respects for combustion to obtain heat
or for reconversion to electricity near the user. Economically,
transmission of a gas is far cheaper than transmission of electric
power, especially underground. This concept is not without its
problems; nevertheless, it surely deserves detailed consideration
in the future. (auth)

72V38254 1972 ISS 00 TK3231.U48 621.31922 LC-70-616452

ELECTRIC POWER TRANSMISSION AND THE ENVIRONMENT; GUIDELINES FOR THE
PROTECTION OF NATURAL, HISTORIC, SCENIC, AND RECREATIONAL VALUES IN THE
DESIGN AND LOCATION OF RIGHTS-OF-WAY AND TRANSMISSION FACILITIES.

UNITED STATES. FEDERAL POWER COMMISSION.

#WASHINGTON, III, 22 P. ILLUS. 23 CM.

LC ELECTRIC LINES -- ENVIRONMENTAL ASPECTS.

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burgh, Pa., 1972. /
15 Proceedings papers. New York, Order Dept.,
1972 IEEE, 1972.
iii, 96 p. illus. 29 cm.
Held at Pittsburgh, Pa., May 22-24, 1972.
Sponsored by: Insulated Conductors Committee
and the Transmission and Distribution Commit-
tee of the IEEE Power Engineering Society.
"72-CHO 608-0-PWR."
1. Electric power distribution--High ten-
sion--Congresses. I. IEEE Power Engineering
Society. Insu- lated Conductors Committee.

TK
173 IEEE Power Engineering Society Conference on
15 Research for the Electric Power Industry,
Washington, D.C., 1972.
1972 Conference on research for the electric power
industry. [New York, Institute of Electrical
and Electronic Engineers, 1973]
455 p. illus. 28 cm.

SIXTH SESSION - ENERGY TRANSFER I - OVERHEAD TRANS-
MISSION SYSTEMS. P.225-281.
SEVENTH SESSION - ENERGY TRANSFER II - UNDERGROUND
TRANSMISSION SYSTEMS. P.283-326.

NEW MEANS OF TRANSMITTING ELECTRICITY: A THREE-WAY
RACE. W.D. Metz.
Science, v.178, no.4064, Dec.1,1972, p.968-970.

Three new technologies for underground power trans-
mission are being studied in addition to ways to
improve the conventional overhead transmission lines.

TC
1505 IEEE International Conference on Engineering in the
12 Ocean Environment, Newport, R. I., 1972.
1972 Ocean '72; record. [New York, Institute of
Electrical and Electronics Engineers, 1972]
viii, 613 p. illus. 28 cm.
Held Sept. 13-15, 1972 in Newport, R. I.
"IEEE publication 72 CHO 660-1 OCC."

Cable Development Required for Offshore Generating
Stations, George W. Supplee and Robert W. Metcalfe. 422
Public Service Electric and Gas Company
Solid Dielectric Cables for Underwater Power
Transmission, Peter Graneau, *Underground Power
Corporation* 427
Submarine Cable Burying System with Guiding
Equipment, Kinya Suzuki, Masayoshi Miyake and
Yutaka Wakui, *Nippon Telegraph & Telephone
Public Corporation* 431

(PB-224005-9-GA) ESTIMATION OF AGGREGATE
MILES OF EHV TRANSMISSION LINE NEEDS. Markel, L. C.
(Massachusetts Inst. of Tech., Cambridge (USA)). Aug 1972.
163p. NTIS \$4.75.

Regression analysis is used to develop models for the total
number of miles of EHV line needed in a power system. The
models developed are not meant to be used to design a trans-
mission system, but to examine existing EHV systems to see
if general patterns of relationships exist on a system-wide basis.
Regional US data and projections of load and generation char-
acteristics for the years 1960 to 1990 are used to develop re-
gression models for circuit miles and gigawatt equivalent miles
of EHV transmission line. F and t tests are used to determine
the statistical significance of the model parameters. Methods
of using the models to investigate the effect of new plant siting
strategies or environmental constraints on EHV grid size are
discussed. (GRA)

Development of a multipolar inductor utilizing the
possibilities of hollow superconductors with
supercritical helium circulation --- Acting harmonic
seal/rotating shaft problems Final Report Centre
d'Etudes et Recherches de la Compagnie
Electro-Mecanique, Le Bourget (France). Lab. de
Cyrotechnique. BORDENAVE, J. P. MALANDAIN, A.
MAY 1972 48 PAGES REFS. IN FRENCH

Avail: Issuing activity
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*SUPERCONDUCTING POWER TRANSMISSION, *SUPERCRITICAL FLOW
CIRCULATORS, INDUCTORS, MULTIPOLAR FIELDS, SLIDING FRICTION,
VACUUM SYSTEMS C12 B74-21921

74V29983 1972 ISS 00 TK3144.J62 1972 0-080166-96-2 629.31913
LC-77-138747

A/JONES, BRIAN, A/1939-

NEW APPROACHES TO THE DESIGN AND ECONOMICS OF EHV TRANSMISSION PLANT

#BY, BRIAN JONES.

#1ST ED., PERGAMON PRESS OXFORD, NEW YORK, XI, 248 P. ILLUS. 22 CM.
INTERNATIONAL SERIES OF MONOGRAPHS IN ELECTRICAL ENGINEERING, V. 4
INCLUDES BIBLIOGRAPHICAL REFERENCES.

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73V22398 1972 ISS 00 TK3144.516 621.31922 LC-72-181608

EHV TRANSMISSION LINE CORONA EFFECTS. COURSE COORDINATOR W.

JANISCHEWSKYJ. SPONSORED BY IEEE TRANSMISSION AND DISTRIBUTION
COMMITTEE AND IEEE POWER ENGINEERING EDUCATION COMMITTEE OF THE IEEE
POWER ENGINEERING SOCIETY.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, #NEW YORK, 56 P.
ILLUS. 28 CM.

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SOCIETY. POWER ENGINEERING EDUCATION COMMITTEE. INSTITUTE OF ELECTRICAL
AND ELECTRONICS ENGINEERS. IEEE TUTORIAL COURSE.

MAIN-TITL TRACE-SERS#CORP*AUTH* CATLG BY-LC

73V22860 1972 ISS 00 TK3144.1224 621.31913 LC-72-182976

EXPERIENCE WITH THE AEP 765-KV SYSTEM; PAPERS PRESENTED ON FEBRUARY
3, 1972, AT THE IEEE POWER ENGINEERING SOCIETY 1972 WINTER MEETING AND
R & D CONFERENCE.

IEEE POWER ENGINEERING SOCIETY.

NEW YORK 50 P. ILLUS. 28 CM.

\$4.00 "72 CH0645-2 PWR." SPONSORED BY THE IEEE TRANSMISSION &
DISTRIBUTION COMMITTEE AND THE IEEE POWER SYSTEM ENGINEERING COMMITTEE
OF THE IEEE POWER ENGINEERING SOCIETY. INCLUDES BIBLIOGRAPHICAL
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SOCIETY. POWER SYSTEM ENGINEERING COMMITTEE.

MAIN-CORP TRACE-CORP#TITL* CATLG BY-LC

74V10403. 1972 ISS 00 TK85.D44 1972 621.310947 LC-73-601275
 REPORT OF THE UNITED STATES DELEGATION VISIT TO THE SOVIET UNION,
 JULY 24 TO AUGUST 6, 1972; ELECTRIC POWER TRANSMISSION AND POWER
 GENERATION FACILITIES (U.S.-U.S.S.R. EXCHANGE AGREEMENT)
 DELEGATION OF THE U.S./U.S.S.R. CULTURAL AND SCIENTIFIC EXCHANGE
 PROGRAM CONCERNING HIGH-VOLTAGE POWER TRANSMISSION.
 U.S. GOVT. PRINT. OFF., #WASHINGTON, X, 25 P. ILLUS. 27 CM.
 COVER TITLE. SPONSORED BY THE U.S. BUREAU OF RECLAMATION.
 LC ELECTRIC ENGINEERING -- RUSSIA. ELECTRIC POWER DISTRIBUTION --
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72V33703. 1972 ISS 00 TK3144.E28 0-132473-38-0 621.319 LC-70-172065
 A/EATON, JAMES ROBERT, A/1902-
 ELECTRIC POWER TRANSMISSION SYSTEMS #8Y. J. ROBERT EATON.
 PRENTICE-HALL ENGLEWOOD CLIFFS, N.J., XVIII, 365 P. ILLUS. 24 CM.
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73A11826* ISSUE 2 PAGE 200 CATEGORY 26 72/00/00 746 PAGES
 UNCLASSIFIED DOCUMENT
 APPLIED SUPERCONDUCTIVITY CONFERENCE, 5TH, ANNAPOLIS, MD., MAY 1-3,
 1972, PROCEEDINGS. \$20
 CONFERENCE SPONSORED BY THE NATIONAL SCIENCE FOUNDATION, NASA,
 INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, AMERICAN INSTITUTE
 OF PHYSICS, AND U.S. NAVY. NEW YORK, INSTITUTE OF ELECTRICAL AND
 ELECTRONICS ENGINEERS, INC., 1972. 746 P
 /*CONFERENCES/*SUPERCONDUCTIVITY/*TECHNOLOGY UTILIZATION/
 CRYOGENICS/ ELECTRIC GENERATORS/ ELECTRIC POWER TRANSMISSION/ JOSEPHSON
 JUNCTIONS/ MICROWAVE EQUIPMENT/ NUCLEAR FUSION/ PARTICLE ACCELERATORS/
 SUPERCONDUCTING MAGNETS/ THIN FILMS/ TRANSITION TEMPERATURE

High Voltage Direct Current Transmission.

Robert L. Shedden.
Cornell Univ., Ithaca, N.Y. Cornell Energy Project. Jan 71.
25p Paper-71-1, NSF-RA/N-71-001
PB-228 885/0WE PC\$4.25/MF\$1.45

The report contains a brief summary of the technical status of high-voltage direct-current electric-power transmission in the United States and abroad. Since the first major d-c link from Stockholm to the island of Gotland began operation in 1954, at least six additional large-scale lines have been commissioned. In this country the 1500 Mw, 825-mile Pacific Intertie J is the only project that has been completed. Solid-state systems are under design and construction. A sampling of the extensive bibliography on this subject is included, as well as an appendix which summarizes pertinent details on a number of the major lines. (Author)

SUPERCONDUCTING POWER TRANSMISSION.

R.W. Meyerhoff, Union Carbide Corp.
Cryogenics, v.11, no.2, Apr.1971, p.91-101.

Review article.

Cryogenic and Superconductive Systems for Electrical Power Transmission.

Keith Sheidler.
Cornell Univ., Ithaca, N.Y. Cornell Energy Project. Jan 71.
11p Paper-71-2, NSF-RA/N-71-002
PB-228 861/1WE PC\$4.00/MF\$1.45

A brief survey is presented of the current status of cryogenic and superconductive transmission line research in the United States. (Modified author abstract)

Cost Comparison between Natural Gas and Electricity.

Rob Hogue.
Cornell Univ., Ithaca, N.Y. Cornell Energy Project. Jun 71.
13p Paper-71-7, NSF-RA/N-71-007
PB-228 862/9WE PC\$4.00/MF\$1.45

Results are reported of a cost comparison study of gas versus electrical transmission of large blocks of energy. Representative present-day gas-line operating standards and procedures were obtained by consultation with operating engineers of several gas transmission companies. Results of the application of these guidelines to a number of gas lines are compared with the standard costs of operation of electrical lines that can transmit equivalent amounts of energy for similar distances. Comparisons are presented in several tables, which show that transmission of energy via gas is significantly more economical than by electricity in construction costs, distribution costs, and in fuel costs. Table 4 is of particular interest for the data on corresponding power capabilities for several pipe diameters. Table 3 contains useful comparisons of consumption and distribution costs of gas versus electricity by the lower 48 states of the United States. (Author)

N73-10727# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THE QUESTION OF ac SUPERCONDUCTING POWER TRANSMISSION

E. N. Zuev 21 Apr. 1972. 24 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Energ. i Transp. (Moscow), no. 1, 1971 p 45-54
(AD-745846; FTD-MT-24-1380-71) Avail: NTIS CSCL 09/1

The results of work on evaluating possible circuits and the electrical and dimensional characteristics of superconducting ac power transmission for the purpose of developing their possibilities in the transport of large amounts of power are presented. A method of calculating the fundamental electrical parameters and structural dimensions of lines with coaxial current-carrying elements taking into account a number of technical limitations, and especially the limitation of the power to be transmitted with the condition of steady-state stability is given. The question of reaching an optimum relationship between the powers which are maximum under the conditions of retaining the superconducting state and of the steady-state stability of power transmission is examined.

Author (GRA)

73V30918 1971 ISS 00 TK3101.U55 621.3190973 LC-72-616371
 A REPORT TO THE FEDERAL POWER COMMISSION ON THE TRANSMISSION OF
 ELECTRIC POWER. PREPARED FOR THE NATIONAL POWER SURVEY.
 UNITED STATES. FEDERAL POWER COMMISSION. TRANSMISSION TECHNICAL
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 #WASHINGTON, XV, 192 P. ILLUS. 27 CM.
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 NEW YORK (STATE). DEPT. OF PUBLIC SERVICE. POWER DIVISION. SYSTEM
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 SYSTEMS, 26-29 APRIL 1971.
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 THE INSTITUTION OF ELECTRICAL ENGINEERS AND OTHERS; HELD AT THE
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74V41101 1970 ISS CC TK30C1.C65 1970 C-340C49-24-3 021.319
LC-79-557475

A/COTTON, HARRY, A/1889-
THE TRANSMISSION AND DISTRIBUTION OF ELECTRICAL ENERGY BY H.
COTTON.

3RD ED. BY H. COTTON AND H. BARBER. ENGLISH UNIVERSITIES PRESS,
LONDON, VII, 472 P. ILLUS. 23 CM.

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J. D. M. Phelps, P. S. Pugh and J. E. Bechler, "765-kV station insulation coordination", IEEE Trans. Power Apparatus and Systems, vol. PAS-88 pp. 1377-1382
S. H. Horowitz and H. T. Seeley, "Relaying the AEP 765-kV system", IEEE Trans. Power Apparatus and Systems, vol. PAS-88 pp. 1382-1389

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TK3351.I5 1969

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427 p.

see also: TK3351.I5 1969 suppl.

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 5 Proceedings. Chicago, Illinois Institute of
 Technology [c1969]
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 xxiv, 1284 p. illus. 23 cm.
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Technical and Other Considerations Leading to Initiation of 765 kV
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 H. C. BARNES; American Electric Power Service Corporation

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 V. I. POPKOV, USSR Academy of Sciences

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 FRANK A. DENBROCK; Commonwealth Associates, Inc.

73V30031 1969 ISS 00 TK3091.P3213 621.319 LC-72-607358
 PARAMETRY I PEREKHOVNYE REZHIMY DAL NIKH ELEKTRICPEREDACH. ENGLISH
 LONG-DISTANCE POWER TRANSMISSION; PARAMETERS AND TRANSIENTS. O. V. CL
 SHEVSKII, EDITOR. TRANSLATED FROM RUSSIAN #AND EDITED BY G. D. MYERS.
 ISRAEL PROGRAM FOR SCIENTIFIC TRANSLATIONS; #AVAILABLE FROM THE U.S.
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IEEE-EHV TRANSMISSION CONFERENCE, MONTREAL, 1968.
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A/FREEMAN, PETER JOHN.
ELECTRIC POWER TRANSMISSION AND DISTRIBUTION, BY P. J. FREEMAN.
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PEREDACHA ELEKTRON ENERGI PEREMENNYM TOKOM NA RASSTO I ANI I A
1500-3000 KM. ENGLISH A-C POWER TRANSMISSION OVER DISTANCES OF 1500 TO
3000 KM. (PEREDACHA ELEKTRON ENERGI PEREMENNYM TOKOM NA RASSTOYANIYA
1500 - 3000 KM.) V. K. SHCHERBAKOV, EDITOR. #TRANSLATED FROM RUSSIAN BY
J. NITZAN. EDITED BY G. D. MYERS.
ISRAEL PROGRAM FOR SCIENTIFIC TRANSLATIONS #AVAILABLE FROM THE U.S.
DEPT. OF COMMERCE, CLEARINGHOUSE FOR FEDERAL SCIENTIFIC AND TECHNICAL
INFORMATION, SPRINGFIELD, VA. JERUSALEM, IV, 182 P. ILLUS. 24 CM.
IN ENGLISH, RUSSIAN AT HEAD OF TITLE ACADEMY OF SCIENCES OF THE
USSR. SIBERIAN BRANCH. STATE PRODUCTION COMMITTEE FOR POWER ENGINEERING
AND ELECTRIFICATION OF THE USSR. PROCEEDINGS OF THE SIBERIAN
SCIENTIFIC-RESEARCH INSTITUTE FOR POWER ENGINEERING, ISSUE 1(20).
INCLUDES BIBLIOGRAPHIES.
LC ELECTRIC POWER DISTRIBUTION -- ALTERNATING CURRENT. ELECTRIC
LINES.
ADDED SHCHERBAKOV, VASIL I KUZ MICH, ED.
MAIN-TITL TRACE-AUTH* CATLG BY-LC
/ / PUBL IN ISRAEL

TK3301.B3 1966

Power cables: their design and installation.

Barnes, Cyril Charles.

Power cables: their design and installation, by, C. C. Barnes. With a foreword by Sir John Hacking. 2nd ed. London, Chapman & Hall, 1966.

xv, 393 p. illus., 16 plates, tables, diagra. 24 cm. 0/-

(B 66-23253)

Label mounted on t. p.: New York, Barnes & Noble.
Bibliography: p. 387-387.

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72V13920 1966 ISS 00 TK3251.U63 LC-67-61920
UNDERGROUND POWER TRANSMISSION, A REPORT TO THE FEDERAL POWER
COMMISSION.

UNITED STATES. FEDERAL POWER COMMISSION. ADVISORY COMMITTEE ON
UNDERGROUND TRANSMISSION.

#WASHINGTON. XIII, 43 P. ILLUS. 27 CM.

INCLUDES ALSO APPENDIX A-D, EACH PAGED SEPARATELY. BIBLIOGRAPHY P.
D2-D11.

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MAIN-CORP TRACE-TITL* CATLG BY-LC

73V26643 1960 ISS 00 TK3144.E44 LC-72-208101
HIGH VOLTAGE TRANSMISSION SYSTEM; REPORT ON 220 KV TRANSMISSION
SYSTEM FOR YUGOSLAVIA. PREPARED FOR ZAJEDNICA JUGOSLOVENSKE
ELEKTROPRIVREDE JUGEL, BY ENGINEERING CONSULTANTS, INC., TECHNICAL
CONSULTANT FOR UNITED STATES OF AMERICA OPERATIONS MISSION TO
YUGOSLAVIA, AMERICAN EMBASSY, BELGRADE.
ENGINEERING CONSULTANTS.

DENVER, 63 L. ILLUS., MAPS (PART FOLD., PART COL.) 29 CM.

LC ELECTRIC POWER DISTRIBUTION -- YUGOSLAVIA -- HIGH TENSION.

ADDED E#YU** ZAJEDNICA JUGOSLOVENSKE ELEKTROPRIVREDE.

MAIN-CORP TRACE-TITL* CATLG BY-LC

1974

THE TECHNOLOGY AND APPLICATION OF FREE SPACE POWER TRANSMISSION BY MICROWAVE BEAM.

W.C. Brown.

IEEE Proceedings, v.62, no.1, Jan.1974, p.11-25.

The technology is examined in terms of the microwave beam itself, and the conversion technology between microwaves and dc power at either end of the system. The potential applications are discussed in terms of the unique characteristics of microwave power transmission.

A74-24271 * Photon machines. A. Hertzberg, W. H. Christiansen, and E. W. Johnston (Washington, University, Seattle, Wash.). In: Fundamental and applied laser physics. (A74-24265 10-16) New York, Wiley-Interscience, 1973, p. 141-164. 18 refs. Grant No. NGL-48-002-044.

The basic thermodynamics of thermal lasers of the gas-dynamic type are reviewed, and it is shown that an efficient coherent photon generator can be developed on a closed-cycle principle. The efficiency limits of such a device are explored, and the results of the analysis indicate that the production efficiency of coherent radiation from heat can, in the limit of high component efficiency, be equal to that of the production of work. An indispensable element of any power transmission system also involves an engine capable of transforming the transmitted energy into useful shaft power. It is shown that a closed-cycle system may also be developed in principle which can transform the transmitted laser radiation into shaft power with an efficiency approaching one.

(Author)

N74-19702* # National Aeronautics and Space Administration. Pasadena Office, Calif.
ELECTRIC POWER GENERATION SYSTEM DIRECTLY FROM LASER POWER Patent Application
Katsunori Shimada, inventor (to NASA) (JPL) Filed 27 Mar. 1974 17 p
(Contract NAS7-100)

(NASA-Case-NPO-13308-1; US-Patent-Appl-SN-455164) Avail: NTIS HC \$4.00 CSCL 10A

A system is reported in which laser power is directly converted into electric power. Liquid cesium is ionized by a laser beam with a collector spaced apart from the cesium to collect either the cesium ions or free electrons; thus, a potential difference between the collector and the cesium liquid is produced. NASA

A73-23601 Satellite power stations - A new source of energy. W. C. Brown (Raytheon Co., Lexington, Mass.). IEEE Spectrum, vol. 10, Mar. 1973, p. 38-47. 30 refs.

It has been suggested by Glaser (1968) that large arrays of solar photovoltaic cells should be placed into space in near-equatorial synchronous orbit where the sun would shine upon them nearly 100 per cent of the time. The dc power obtained from the photovoltaic arrays would then be converted into microwave power, beamed to the surface of the earth, and there converted back into dc power. This concept has become known as the Satellite Solar Power Station (SSPS). The system configuration and characteristics of the SSPS are discussed together with the solar photovoltaic cell array, details of the microwave power transmission system, and side effects of the SSPS system. G.R.

A74-40094 * Gasdynamic lasers and photon machines. W. H. Christiansen and A. Hertzberg (Washington, University, Seattle, Wash.). *IEEE, Proceedings*, vol. 61, Aug. 1973, p. 1060-1072. 35 refs. NASA-Navy-USAF-supported research.

The basic operational highlights of CO₂-N₂ gasdynamic lasers (GDL's) are described. Features common to powerful gas lasers are indicated. A simplified model of the vibrational kinetics of the system is presented, and the importance of rapid expansion nozzles is shown from analytic solutions of the equations. A high-power pulsed GDL is described, along with estimations of power extraction. A closed-cycle laser is suggested, leading to a description of a photon generator/engine. Thermodynamic analysis of the closed-cycle laser illustrates in principle the possibility of direct conversion of laser energy to work. (Author)

ENERGY RELAY SATELLITES URGED FOR SHUTTLE. C. Covault. Aviation Wk & Space Tech., Jan. 8, 1973, p. 47, 48.

Dr. Krafft Ehrlicke's proposal for microwave energy relay satellites in geosynchronous orbit. Powerful earth-based atomic power plants, located in unpopulated areas of the earth, would furnish power to wide areas of earth via the space microwave relay system.

A74-16380 * Gas lasers and applications. C. F. Hansen (NASA, Ames Research Center, Moffett Field, Calif.). In: Recent developments in shock tube research. Proceedings of the Ninth International Symposium, Stanford, Calif., July 16-19, 1973. (A74-16375 05-12) Stanford, Calif., Stanford University Press, 1973, p. 47-58. 28 refs.

A brief review of laser elements is given. Flowing gas lasers are represented to have the best potential for high average power. The background of shock-tube researchers and the shock tube itself are alleged to be ideally suited for the development of such lasers. Three types - the electric discharge, the gasdynamic, and the chemical laser - are discussed briefly. A legion number of possible gas lasers is enumerated. With the development of their potential for higher power and efficiency, many additional and important uses of lasers are predicted, even beaming power through space for long distances, up to 1 AU. A few details of some current high-power gasdynamic laser devices are given. (Author)

A74-16116 Regional and global energy transfer via passive power relay satellites. K. A. Ehrlicke (Rockwell International Corp., Space Div., Downey, Calif.). In: Technology today and tomorrow. Proceedings of the Tenth Space Congress, Cocoa Beach, Fla., April 11-13, 1973. (A74-16101 04-31) Cape Canaveral, Fla., Canaveral Council of Technical Societies, 1973, p. 5-15 to 5-94. 23 refs.

The Power Relay Satellite (PRS) offers interesting possibilities as a feasible, shuttle-compatible method of transferring energy over continental or global distances. The basic principle of the PRS is that a microwave reflector is placed into geosynchronous orbit to redirect energy beamed from a power generation system (power source) to a receiver at a great distance from the power source. There the microwave energy is converted back to electricity for local distribution. Particulars of the transmitter antenna are given. The technology of converting electricity to microwave power was advanced greatly with the development of crossed-field devices. They operate on the principle of electron motion in a crossed electric and magnetic field. Microwave beam transmission is examined. Energy sources and primary electric power plants (PEPPs) in the United States are discussed. Attention is given to the shuttle compatibility of space relaying and its comparison with space power generation. F.R.L.

ADAPTING MICROWAVE TECHNIQUES TO HELP SOLVE FUTURE ENERGY PROBLEMS. The relationship between microwave techniques and the growing concern for future sources of energy is reviewed. The relationship is specifically explored in the use of a microwave beam to efficiently transport power from an array of solar photovoltaic cells in space to the earth's surface. The transition from a laboratory technology of microwave power transmission to a 10-Gw 23, 200-mi transmission system is examined in detail. 26 refs.

Brown, William C. Raytheon Co. Waltham, Mass. *IEEE Trans Microwave Theory Tech* v MTT-21 n 12 . Dec 1973 p 753-763.

N73-20257 # National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala. MICROWAVE POWER TRANSMISSION SYSTEM Patent Application William J. Robinson, inventor (to NASA) Filed 13 Mar. 1973 12 p (NASA-Case-MFS-21470-1; US-Patent-Appl-SN-240871) Avail: NTIS HC \$3.00 CSCL 09C

A microwave, wireless, power transmission system is presented in which the transmitted power level is adjusted to correspond with power required at a remote receiving station in which deviations in power load produce an antenna impedance mismatch causing variations in energy reflected by the power receiving antenna at the receiving station.

N74-19870* National Aeronautics and Space Administration.
Marshall Space Flight Center, Huntsville, Ala.
**MICROWAVE POWER TRANSMISSION SYSTEM WHEREIN
LEVEL OF TRANSMITTED POWER IS CONTROLLED BY
REFLECTIONS FROM RECEIVER** Patent
William J. Robinson, Jr., inventor (to NASA) Issued 5 Mar.
1974 5 p Filed 13 Mar. 1973 Supersedes N73-20257 (11 -
11, p 1264)

(NASA-Case-MFS-21470-1; US-Patent-3,795,910;
US-Patent-App-SN-340871; US-Patent-Class-343-7.5;
US-Patent-Class-325-62; US-Patent-Class-333-17;
US-Patent-Class-343-17.7) Avail: US Patent Office
CSCS
09C

A microwave, wireless, power transmission system is described in which the transmitted power level is adjusted to correspond with power required at a remote receiving station. Deviations in power load produce an antenna impedance mismatch causing variations in energy reflected by the power receiving antenna employed by the receiving station. The variations in reflected energy are sensed by a receiving antenna at the transmitting station and used to control the output power of a power transmitter. Official Gazette of the U.S. Patent Office

NASA Tech. Brief B73-10353

LASER ENERGY CONVERTED INTO ELECTRIC POWER.

Katsunori Shimada, Caltech/JPL.

August 1973.

Project a laser beam of sufficient power to the remote site and then convert the laser energy directly into electric power.

THE SATELLITE NUCLEAR POWER STATION.

Space World, v.J-6-114, June 1973, p.4-18.

The Satellite Nuclear Power Station would transmit power safely to the ground by a microwave beam.

A74-21002* Phased arrays of lasers for power transmission.
A. A. Vetter (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Electro-Optical Systems Design Conference, 5th, New York, N.Y., September 18-20, 1973. Proceedings of the Technical Program. (A74-20988 08-14) Chicago, Industrial and Scientific Conference Management, Inc., 1973, p. 283-293. 10 refs. Contract No. NAS7-100.

The phased array is a group of regularly spaced lasers with parallel optical axes. Each laser of the group emits light of the same wavelength and the same phase. Mathematical models of laser transmission systems with regular arrays are presented, taking into account rectangular apertures. It is found that an array of free running lasers has the same normalized expectation value as the single laser, with the actual power a factor of N greater. G.R.

A73-22822* Laser energy transfer - An analytic survey of high power applications. R. D. Arno, J. S. MacKay, and K. Nishio (NASA, Ames Research Center, Advanced Concepts and Missions Div., Moffett Field, Calif.). In: Intersociety Energy Conversion Engineering Conference, 7th, San Diego, Calif., September 25-29, 1972. Proceedings. (A73-22751 09-03) Washington, D.C., American Chemical Society, 1972, p. 1116-1124. 10 refs.

A72-42481 Progress in the efficiency of free-space microwave power transmission. W. C. Brown (Raytheon New Products Center, Waltham, Mass.). (International Microwave Power Institute, Annual Symposium on Microwave Power, 7th, Ottawa, Canada, May 24-26, 1972.) Journal of Microwave Power, vol. 7, Sept. 1972, p. 223-230. 9 refs.

Recent developments in rectenna design and microwave beam launching have increased the ratio of the dc power output from the rectifier at the receiving point to the rf power input to the transmitting antenna from 0.41 to 0.60. The efficiency of microwave beam launching has been improved through the use of the dual-mode horn which has exceptionally low power loss in its side lobes. Improvement in the efficiency at the receiving point has resulted from increased capture efficiency of the rectenna. (Author)

A73-22781 Satellite solar power station - An option for power generation. P. E. Glaser (Arthur D. Little, Inc., Cambridge, Mass.). In: Intersociety Energy Conversion Engineering Conference, 7th, San Diego, Calif., September 25-29, 1972, Proceedings. (A73-22761 09-03) Washington, D.C., American Chemical Society, 1972, p. 507-511, 7 refs.

The principle on which a satellite solar power station (SSPS) is based is the conversion of solar energy into electricity. This electricity would be fed to microwave generators arranged to form an antenna which, in turn, could direct a beam to a receiving station on the earth where the microwave energy could be efficiently and safely converted back to electricity to meet baseload power needs. The status of the technology required to meet the objectives of an SSPS is discussed.
F. R. L.

THE GENERATION OF POLLUTION-FREE ELECTRICAL POWER FROM SOLAR ENERGY. W.R. Cherry, NASA Goddard Space Flight Center. Jour. Engineering for Power, v.94, Ser.A, Apr.1972, p.78-82.

A72-35328 * # Laser power stations in orbit. C. F. Hansen and G. Lee (NASA, Ames Research Center, Physical Gasdynamics and Lasers Branch, Moffett Field, Calif.). *Astronautics and Aeronautics*, vol. 10, July 1972, p. 42-55, 52 refs.

Potential laser applications for space-borne power generation are discussed in the light of the current state of the art. The feasible ranges of various laser classes with standing waves are estimated. Power and efficiency, mirror factors, phased-array performance and beam patterns are analyzed as selection characteristics. Other topics include the maximum receiving-element size, energy conversion, pointing and tracking, causes of deformation, and mirror distortions.

A73-16161

Calculation of input-voltage standing-wave ratio for a reflector antenna. G. T. Poulton, S. H. Lim (Queen Mary College, London, England), and P. H. Masterman (Signals Research and Development Establishment, Christchurch, Hants., England). *Electronics Letters*, vol. 8, Dec. 14, 1972, p. 610, 611, 5 refs.

The input-voltage standing-wave ratio (v.s.w.r.) of a feed for a reflector-antenna system depends on the mismatch of the horn to free space and the reflection of energy back into the feed. Both these effects must be minimized to ensure a low v.s.w.r. A general computational method is formulated by making use of a power transfer theorem by Robieux (1959), describing the efficiency of coupling between two apertures. Measured and predicted v.s.w.r. against frequency patterns for 6 deg scalar horn feed with subreflector are shown in a graph.
G. R.

N72-22213* # National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

MICROWAVE POWER TRANSMISSION CONSIDERATIONS FOR EARTH ORBITAL SPACE MISSIONS c10 W. J. Robinson, Jr. In *its Res. Achievements Rev.*, Vol. 4, Report no. 4 Feb. 1972 p. 63-66 refs (See N72-22207 13-09)

Avail: NTIS CSCL 09C

Investigation revealed that the use of microwaves and lasers was feasible for transferring electrical power in space. The results of the study led to a consideration of microwaves for electric power transmission between earth orbital satellites in the late 70's or early 80's. Efforts to develop design information for planning purposes are discussed.
K.P.D.

"Status of the Technology and Applications of Free-Space Microwave Power Transmission" V. C. Brown

7

TK782.I61 1971

IEEE-GMT International Microwave

Symposium

A72-10925 * # Laser power transmission. H. G. Ahlstrom, W. H. Christiansen, and A. Hertzberg (Washington, University, Seattle, Wash.). *Trend in Engineering*, vol. 23, Oct. 1971, p. 20-29, 18 refs. Grant No. NGR-48-002-044.

Description of studies which have led to the design of a conceptual device in which the limitation of transforming heat into coherent radiation can be examined. By exploring the basic thermodynamic relationships controlling the operation of this device, it is concluded that a closed-cycle gasdynamic laser is possible in which all of the shaft energy supplied can be turned into laser radiation. Hence, it is possible in principle to convert heat into coherent radiation with approximately the same efficiency with which heat may be converted into electricity. By modifying the closed-cycle-gasdynamic-laser system, this system can be operated in reverse and the incoming radiation may be used to pump the gas in the loop so that shaft power can be extracted. By carefully controlling the temperature distribution in this machine, laser energy can be converted into useful shaft energy with an efficiency approaching 1. M.M.

A71-18557 * # Photon generators and engines for laser power transmission. A. Hertzberg, E. W. Johnston, and H. G. Ahlstrom (Washington, University, Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 9th, New York, N.Y., Jan. 25-27, 1971, Paper 71-106*, 17 p. 38 refs. Members, \$1.50; nonmembers, \$2.00. Grant No. NGL-48-002-044.

The development of gas laser technology leading to the present capability of generating high power continuous and pulsed coherent radiation is briefly reviewed. It is pointed out that through these developments it is now possible to consider the radiant transmission of power. The basic thermodynamics of thermal lasers of the gas dynamic type are reviewed, and it is shown that a highly efficient coherent photon generator can be developed on a closed cycle principle. The efficiency limits of such a device are explored, and the results of the analysis indicate that the production efficiency of coherent radiation from heat can, in the limit, be equal to that of the production of electricity from heat. An indispensable element of any power transmission system also involves an engine capable of transforming the transmitted energy into useful shaft power. It is shown that a closed cycle system may also be developed which can transform the transmitted laser radiation into shaft power with an efficiency approaching one. (Author)

Dec 03 AIAA J. V. 10, No. 4, Apr. 72, p. 394 -

W. C. Brown, "The Receiving Antenna and Microwave Power Rectification", *Journal of Microwave Power*, Vol. 5, No. 4, DEC. 1970.

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Technology utilization ideas for the 70's and beyond. Edited by F. W. Forbes [and] P. Dergarabedian. Tarzana, Calif., AAS Publications Office [1971] xiv, 315 p. illus. 25 cm. (AAS science and technology series, v. 26)
An American Astronautical Society publication. Proceedings of a special AAS/AIAA technical event, held October 30, 1970 at Winrock, Arkansas at the invitation of Governor Winthrop Rockefeller.

Power from Space - Technology Transfer for Human Survival (AAS70-088)

Peter E. Glaser

N71-22180* # Raytheon Co., Waltham, Mass. Microwave and Power Tube Div.

A MICROWAVE BEAM POWER TRANSFER AND GUIDANCE SYSTEM FOR USE IN AN ORBITAL ASTRONOMY SUPPORT FACILITY Final Report, 10 Dec. 1969 - 10 Dec. 1970

William C. Brown 10 Dec. 1970 135 p refs (Contract NAS8-25374)

A microwave beam is studied as a means of transferring power between satellites. Emphasis of the study is upon the basic elements of microwave power generation, transmission, and capture and rectification. Experimental work included an accurate measurement of overall dc to dc efficiency of 27% in a laboratory system, and a beam-riding vehicle capable of simultaneously receiving power and automatically positioning itself for maximum power transfer. Author

P. Guenard, "High Power Linear Beam Tube Devices", *Journal of Microwave Power*, Vol. 5, No. 4, DEC. 1970

A71-28667 * Wireless power transmission in a space environment. William J. Robinson, Jr. (NASA, Marshall Space Flight Center, Huntsville, Ala.). (*International Microwave Power Institute, Symposium, 5th, The Hague, Netherlands, Oct. 7-9, 1970.*) *Journal of Microwave Power*, vol. 5, Dec. 1970, p. 233-243. 8 refs.

NASA plans to have a space station complex in earth orbit by the late 70's to provide a facility for performing scientific experiments over long periods. The plans call for a space station, experimental modules, and logistic vehicles. The experimental modules will include free-flying observatories equipped to measure radiation sources such as X-ray, stellar, solar, and high-energy. The problem of providing electrical power to these free flying satellites has no clear-cut solution. Microwave power transmission is one of several proposed solutions being evaluated by NASA. The current in-house and contractually supported programs have surveyed the present status of microwave power transmission and sponsored experimental measurements on the overall efficiency of a microwave power transmission link. These experimental results are described.

(Author)

A71-28866 Microwave power transmission from an orbiting solar power station. G. Goubau (U.S. Army, Institute for Exploratory Research, Fort Monmouth, N.J.). (*Journal of Microwave Power*, vol. 5, Dec. 1970, p. 223-231. 6 refs.

The paper considers the problem of microwave power transmission from an orbiting solar power station to the earth. In particular, questions such as the optimum frequency range, antenna dimensions and mechanical tolerances, phasing and directional control, and attainable transmission efficiencies are discussed.

(Author)

A71-28668 High power microwave generators of the crossed-field type. William C. Brown (Raytheon Co., Waltham, Mass.). (*International Microwave Power Institute, Symposium, 5th, The Hague, Netherlands, Oct. 7-9, 1970.*) *Journal of Microwave Power*, vol. 5, Dec. 1970, p. 245-259. 8 refs.

The proposal to obtain electrical energy from the sun by means of an enormous solar cell array positioned in space at synchronous orbit altitude places a challenging requirement upon the means of converting this energy into microwave form so that it can be relayed to the earth's surface. Crossed-field device technology is consistent with the needs for high efficiency, long life, and for either modest or very high power levels in the dc to rf energy conversion process. A dc to rf energy conversion efficiency of 93% and an overall efficiency of 86% have been demonstrated in a high power magnetron. Continuous power over 400 kW at 3000 MHz and an efficiency of 76% have been obtained from the Amplitron, a crossed-field amplifier device. The development of a pure-metal, secondary emitter cathode provides long life capability. Newly developed permanent magnet material provides the high magnetic fields needed for high efficiency with low resulting weight.

(Author)

A71-28665 Power without pollution. Peter E. Glaser (Arthur D. Little, Inc., Cambridge, Mass.). *Journal of Microwave Power*, vol. 5, Dec. 1970, p. 211-222. 33 refs.

A concept for a satellite solar power station is described to meet future large scale electrical power requirements without burdening the environment or leading to natural resource exhaustion. Considerations are given to solar energy conversion, microwave generation and transmission, and conversion of microwave energy to electrical power on earth. The system considerations and the development tasks for a large satellite solar power station are reviewed and the potential technological needs are identified.

(Author)

968-34903* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala. **THE FEASIBILITY OF WIRELESS POWER TRANSMISSION FOR AN ORBITING ASTRONOMICAL STATION** William Robinson 27 May 1969 62 p refs Revised (NASA-TM-X-53806) Avail CFSTI CSC1178

An examination is made of the feasibility of using microwave or laser energy for wireless transfer of power from a manned, earth-orbiting central station to unmanned astronomical substations. This is a recent conception, and details of a power-transfer system have not been established. Therefore, the possibility of wireless power transfer is judged on the basis of the state of research and development in power generation, transmission, and conversion.

Author

A70-15649 # **PROGRESS IN THE DESIGN OF RECTENNAS.**

W. C. Brown (Raytheon Co., Waltham, Mass.). (*International Microwave Power Institute, International Symposium on Microwave Power, 4th, Edmonton, Canada, May 21-23, 1969, Paper E.5.*)

Journal of Microwave Power, vol. 4, Oct. 1969, p. 168-175.

Review of progress in the design of "rectennas," devices used to collect and rectify the microwave energy at the receiving end of a microwave beam power transmission system. A new lightweight rectenna which provides 20 W of power but weighs only 20 g is described. Future trends in construction are discussed.

(Author)

A69-42534

EXPERIMENTS INVOLVING A MICROWAVE BEAM TO POWER AND POSITION A HELICOPTER.

William C. Brown (Raytheon Co., Burlington, Mass.).

IEEE Transactions on Aerospace and Electronic Systems, vol. AES-5, Sept. 1969, p. 692-702, 14 refs.

Description of two different experiments involving a microwave beam and a helicopter. The first experiment utilized a CW microwave beam to supply a small helicopter with all of the power that it needed for its propulsion. The second experiment utilized an unmodulated CW microwave beam for supplying a position reference to the helicopter with respect to roll, pitch, yaw, and horizontal translation. The second experiment also involved the construction of a fully articulated helicopter and a complete control system carried on board the helicopter. An attempt is made to relate the small scale experiments and the present state of component technology to practical, full scale microwave-powered helicopter systems that can operate at altitudes of up to 50,000 ft. (Author)

A69-15000

PROPULSION ASSISTED BY MICROWAVE POWER.

J. M. Bonneville (NASA, Electronics Research Center, Cambridge, Mass.).

(Symposium on Microwave Power, Boston, Mass., Mar. 22, 1968, Paper D 2.)

Journal of Microwave Power, vol. 3, Dec. 1968, p. 187-193, 12 refs.

Study of practical applications of microwaves to various propulsion requirements including spacecraft launching, power transmission in space, and ground takeoff assist (for aircraft) for fuel economy. Power requirements are presented for some specific cases, and problems associated with the use of microwaves as part of the power system are outlined, as are some means of isolation. B. H.

A68-14611

THE MICROWAVE-POWERED HELICOPTER SYSTEM.

W. C. Brown and J. R. Mims (Raytheon Co., Research Div., Spencer Laboratory, Microwave and Power Tube Div., Burlington, Mass.).

Journal of Microwave Power, vol. 2, Nov. 1967, p. 111-122, 6 refs.

Development of the next phase of the microwave-powered helicopter system. This next phase, which is nearing completion, is the design of a complete microwave-powered helicopter, which will position itself on the microwave beam. For this purpose, a completely articulated helicopter complete with tail rotor and a commensurate has been the development of new solid-state diodes with a high ratio of dc-power output to weight, and integrated circuits. The new diodes make it possible to build a complete receiving antenna and rectifier with a power output of nearly a kilowatt and a weight of 2 lb, while the integrated circuits have made it possible to build a sophisticated control system including sensors and servomotors with a weight of less than 2 lb. P. V. I.

A66-25784

ELECTRONIC COMPONENTS FOR MICROWAVE POWER ENGINEERING.

William C. Brown (Raytheon Co., Microwave and Power Tube Div., Burlington, Mass.).

Electronic Progress, vol. 9, no. 4, 1965, p. 9-13, 8 refs.

Description of electronic components for microwave power engineering capable of generating power up to levels of perhaps as high as 1000 kw and rectifying power up to 100 kw. The quasi-optical approach constituted by the electromagnetic amplifying lens (EAL) is illustrated. In principle, the EAL is a device with a large window at either end and an unlimited number of microwave channels through which microwave energy may flow from one face of the lens to the other. As the power flows through the device, its power level is boosted by a dc-rf conversion process which allows the power to flow at nearly the velocity of light and avoids having to slow the wave down to interact with the electrons. It is pointed out that it is also possible that microwave rectifiers which must handle very large amounts of power will be developed along similar quasi-optical lines. M. M.

A65-21893

AN EXPERIMENTAL MICROWAVE-POWERED HELICOPTER.

W. C. Brown, J. R. Mims, and N. I. Heenan (Raytheon Co., Microwave and Power Tube Div., Spencer Laboratory, Burlington, Mass.).

(Institute of Electrical and Electronics Engineers, International Convention, New York, N.Y., Mar. 22-26, 1965.)
IEEE International Convention Record, vol. 13, pt. 5, 1965, p. 225-235.

Description of successful microwave-powered helicopter experiments and discussion of significant design parameters of this helicopter, with a projection of the impact of available but unused technology upon the payload fraction of the microwave-powered helicopter. The matters presented are: (1) summary of the experi-

ments, (2) description and performance of the major components of the microwave-powered helicopter, (3) helicopter rotor design, (4) the combination receiving antenna and rectifier, (5) the motor, and (6) analyses of the payload fraction of the microwave-powered helicopter. It is concluded that a communications payload of about five pounds could be provided by a 1-hp helicopter. Such a helicopter could operate at altitudes up to ten thousand ft, since lift does not vary greatly with density. A 5-pound communications payload could represent considerable equipment with microminiaturization, particularly in view of the fact that the dc power input at any reasonable voltage may be obtained directly from a small section of the rectenna. M. M.

Brown, W.C.: Experimental Airborne Microwave - Supported Platform. Technical Report No. RADC-TR-65-188.

64-26943

RECTIFICATION OF MICROWAVE POWER.

W. C. Brown (Raytheon Co., Lexington, Mass.) and R. H. George (Purdue University, Lafayette, Ind.).

IEEE Spectrum, vol. 1, Oct. 1964, p. 92-100. 52 refs.

Review of the various possible rectifier approaches to the direct conversion of microwave energy into dc energy at acceptable efficiency, with emphasis upon those already explored. Microwave tube analogs, the closed-spaced thermionic diode, the semiconductor diode, the rectenna, and the multipactor rectifier are discussed. It is concluded that the development of the RF-to-dc conversion device may be considered as being in its early formative stages with practical devices for some types of application now available and with great advances from several different approaches expected for the future.

M. M.

64-22428

EXPERIMENTS IN THE TRANSPORTATION OF ENERGY BY MICROWAVE BEAM.

W. C. Brown (Spencer Laboratory, Burlington, Mass.). (Institute of Electrical and Electronics Engineers, International Convention, New York, N.Y., Mar. 23-26, 1964.)

IEEE International Convention Record, vol. 12, pt. 2, 1964, p. 8-17. 16 refs.

Review of an investigation into the feasibility of utilizing a microwave beam as a means of transporting energy from one point to another. An experiment is described which made use of a CW magnetron operating at 2450 Mc with several hundred watts of power output for the power source. Also employed was a 9.5-ft-diam. ellipsoidal transmitting antenna, a diagonal-horn receiving antenna separated from the transmitting antenna by 25 ft, and a close-spaced thermionic diode rectifier. The overall efficiency as measured from the output of the microwave generator to the input of an electric motor attached to the output of the microwave rectifier at the receiving point was 26%. It is noted that, although the experiment handled a modest amount of power over a short distance, sufficient "on-the-shelf" technology now exists in each of the component areas to increase the power-handling capability and the distance over which power can be transferred by at least a thousandfold.

**465-30526# Raytheon Co., Burlington, Mass. Spencer Lab.
THE CASE FOR THE MICROWAVE POWERED HELICOPTER
AS A COMMUNICATIONS PLATFORM AT 5000-10,000
FOOT ALTITUDE**

W. C. Brown 19 Nov. 1964. 20 p
(AD-465816)

This paper points out and supports with evidence that microwave powered helicopters can be rapidly developed to an operational capability of between one and two miles making use, for the most part, of existing component technology and a conservative approach to microwave antenna design. N.E.A.

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